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TOXICITY PROFILES

TOXICOLOGICAL PROFILE FOR 1,1,1-TRICHLOROETHANE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

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1. PUBLIC HEALTH STATEMENT

This statement was prepared to give you information about 1,1,1-trichloroethane and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,408 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal clean-up activities. 1,1,1-Trichloroethane has been found in at least 696 of the sites on the NPL. However, the number of NPL sites evaluated for 1,1,1-trichloroethane is not known. As EPA evaluates more sites, the number of sites at which 1,1,1-trichloroethane is found may increase. This information is important because exposure to 1,1,1-trichloroethane may cause harmful health effects and because these sites are potential or actual sources of human exposure to 1,1,1-trichloroethane.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to a substance such as 1,1,1-trichloroethane, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, lifestyle, and state of health.

1.1 WHAT IS 1,1,1-TRICHLOROETHANE?

1,1,1 -Trichloroethane is a synthetic chemical that does not occur naturally in the environment. It is also known as methylchloroform, methyltrichloromethane, trichloromethylmethane, and a-trichloromethane. Its registered trade names are chloroethene NU® and Aerothene TT®. It is a colorless liquid with a sweet, sharp odor. 1,1,1 -Trichloroethane dissolves slightly in water. The liquid evaporates quickly and becomes a vapor in the air. Most people begin to smell 1,1,1-trichloroethane in the air when levels reach 120 to 500 parts of 1,1,1-trichloroethane per one million parts of air (ppm). If the chemical makes up 8 to 10.5% (80,000 to 105,000 ppm) of the air, 1,1,1-trichloroethane can bum easily when it comes in contact with a spark or flame. If the vapor bums at high temperatures such as those produced during welding operations, it can produce a poisonous gas known as phosgene. Because of its tendency to evaporate easily, the vapor form is most commonly found in the environment. 1,1,1-trichloroethane also can be found in soil and water, particularly at hazardous waste sites.

1,1,1 -Trichloroethane is used in commercial products, mostly to dissolve other chemicals. About 800 million pounds were produced in 1990, but less is being made today. By the year 1996, 1,1,1-trichloroethane will no longer be made in the United States because it affects the ozone layer. 1,1,1-Trichloroethane has many industrial and household uses. It is often used as a solvent to dissolve other substances, such as glues and paints. In industry, it is widely used to remove oil or grease from manufactured metal parts. In the home, it may be an ingredient of products such as spot cleaners, glues, and aerosol sprays.

You will find detailed information on the chemical properties of 1,1,1 -trichloroethane in Chapter 3. Chapter 4 describes production data and the uses of 1,1,1-trichloroethane.

1.2 WHAT HAPPENS TO 1,1,1-TRICHLOROETHANE WHEN IT ENTERS THE ENVIRONMENT?

Most of the 1,1,1-trichloroethane released into the environment enters the air, where it lasts for about 6 years. Once in the air, it may travel to the upper part of the earth's atmosphere, which is called the stratosphere. There, sunlight breaks it down into other chemicals that may reduce the stratospheric ozone layer. This ozone layer blocks certain damaging ultraviolet rays of the sun from reaching the earth's surface. Some scientists think that the gradual thinning of the ozone layer is causing increases in the number of skin cancer cases in humans.

Spills, improper disposal, industrial emissions, and consumer use can release large amounts of 1,1,1 -trichloroethane into the environment. Contaminated water from landfills and hazardous waste sites may contaminate surrounding soil and nearby surface water or groundwater. However, most of the chemical will probably eventually evaporate into the air. It will not build up in plants or animals. Industrial operations release the largest amount of 1,1,1-trichloroethane into the environment, mostly by emissions into the air. The vapor also enters the air because many products containing the chemical are used in the home and workplace.

We do not know how long 1,1,1-trichloroethane lasts in water or soil. In surface waters such as lakes and rivers, where it partially mixes with water, much of the chemical evaporates quickly into the air. 1,1,1-Trichloroethane also evaporates into the air from soil surfaces. Water can easily carry it through soil into groundwater. 1,1,1 -Trichloroethane in groundwater may evaporate and pass through soil as a gas and finally be released to the air. Also, organisms that live in soil and water may break down 1,1,1-trichloroethane. One study suggests that it takes 200 to 300 days for half of the chemical in contaminated groundwater to break down. However, the number of days may vary widely, depending on specific site conditions.

Chapter 5 provides further information on what happens to 1,1,1-trichloroethane in the environment.

1.3 HOW MIGHT I BE EXPOSED TO 1,1,1-TRICHLOROETHANE?

You can be exposed to 1,1,1-trichloroethane daily from a variety of sources. 1,1,1-Trichloroethane has been found in air samples taken from all over the world. In the United States, city air typically contains about 0.1 to 1.0 parts per billion (ppb) of 1,1,1-trichloroethane; rural air usually contains less than 0.1 ppb. Because 1,1,1-trichloroethane is used so frequently in home and office products, much more is usually found in the air inside buildings (0.3 to 4.4 ppb) than in the outside air (0.1 to 0.9 ppb). Since this chemical is found in many building materials, new buildings can have higher indoor levels than old buildings. Thus, you are likely to be exposed to 1,1,1-trichloroethane vapor at higher levels indoors than outdoors or near hazardous waste sites.

Common consumer products that contain 1,1,1-trichloroethane include glues, household cleaners, and aerosol sprays. In the workplace, you may be exposed to 1,1,1-trichloroethane while using some metal degreasing agents, paints, glues, and cleaning products. You can be exposed to 1,1,1 -trichloroethane by breathing the vapors from these products or by letting the liquid come into contact with your skin. High levels of exposure have occurred in persons who deliberately inhaled the vapors, as in glue-sniffing or solvent abuse.

1,1,1-Trichloroethane has been found in rivers and lakes (up to 0.01 ppm), in soil (up to 120 ppm), in drinking water (up to 0.0035 ppm), and in drinking water from underground wells (up to 5.4 ppm). In one case, drinking water from a private well contained up to 12 ppm, possibly as a result of illegal discharge or spill from a nearby industrial plant. Releases during manufacture and transportation, and during industrial or household use can cause these high levels, but the levels vary substantially from one location to another. Certain foods you eat and water you drink or bathe in may be contaminated with 1,1,1-trichloroethane. However, you can be exposed to 1,1,1-trichloroethane primarily by drinking contaminated water and eating contaminated food. Chapter 5 discusses further information on human exposure to 1,1,1 -trichloroethane.

1.4 HOW CAN 1,1,1-TRICHLOROETHANE ENTER AND LEAVE MY BODY?

1,1,1-Trichloroethane can quickly enter your body if you breathe in air containing it in vapor form. It also enters your body if you drink water or eat food containing 1,1,1-trichloroethane. If you spill 1,1,1-trichloroethane on your skin, most of it quickly evaporates into the air, but small amounts enter your body through your skin. Regardless of how 1,1,1-trichloroethane enters your body, nearly all of it quickly leaves your body in the air you exhale. The small amount that is not breathed out can be changed in your body into other substances, known as metabolites. Most of the metabolites leave your body in the urine and breath within a few days. Chapter 2 provides further information on how 1,1,1-trichloroethane can enter and. leave the body.

1.5 HOW CAN 1,1,1-TRICHLOROETHANE AFFECT MY HEALTH?

If you breathe air containing high levels of 1,1,1-trichloroethane (1,000 ppm or higher) for a short time you may become dizzy and lightheaded, and ,possibly lose your coordination. These effects will rapidly disappear after you stop breathing contaminated air. If you breathe in much higher levels of 1,1,1-trichloroethane, either intentionally or accidentally, you may become unconscious, your blood pressure may decrease, and your heart may stop beating. We do not know whether harmful effects result from breathing low levels of 1,1,1-trichloroethane for a long time. Studies in animals show that breathing air that contains very high levels of 1,1,1-trichloroethane (higher than 2,000 ppm) damages the breathing passages and causes mild effects in the liver, in addition to affecting the nervous system. We do not know if breathing air containing 1,1,1-trichloroethane affects reproduction or development in people. However, when rats were exposed to high levels of 1,1,1-trichloroethane in air, their offspring developed more slowly than normal. Similar exposure of pregnant rabbits delayed the setting of the bone structure of their offspring. These effects on the developing offspring of rats and rabbits were seen only at quite high levels that, in most cases, were toxic to the mother. There are no studies of people that tell us whether eating food or drinking water contaminated with 1,1,1-trichloroethane could cause harmful health effects. However, exposures to people who work with 1,1,1-trichloroethane do not usually cause harmful effects. In animals, placing large amounts of 1,1,1-trichloroethane in the animal's stomach has caused effects on the nervous .system, mild liver damage, unconsciousness, and even death. If your skin comes into contact with 1,1,1-trichloroethane, you might feel some irritation. Studies in animals suggest that repeated exposure of the skin might affect the liver and that very large amounts on the skin can cause death. These effects only occurred when evaporation was prevented.

Available information does not indicate that 1,1,1-trichloroethane causes cancer. The International Agency for Research on Cancer (IARC) has determined that 1,1,1-trichloroethane is not classifiable as to its carcinogenicity in humans. The EPA has also determined that 1,1,1-trichloroethane is not classifiable as to its human carcinogenicity. The likelihood that exposure to levels of 1,1,1-trichloroethane found near hazardous waste sites would cause significant health effects is very low. You can find more information on the health effects of 1,1,1-trichloroethane in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,1,1-TRICHLOROETHANE?

Samples of your breath, blood, and urine can be tested to determine if you have recently been exposed to 1,1,1-trichloroethane. In some cases, these tests can estimate how much 1,1,1-trichloroethane has entered your body. To be of any value, samples of your breath or blood have to be taken within hours of exposure, and samples of urine have to be taken within 1 or 2 days after exposure. These tests will not tell you whether your health will be affected by exposure to 1,1,1-trichloroethane. The exposure tests are not routinely available in hospitals and clinics because they require special analytical equipment. See Chapters 2 and 6 for more information about tests for exposure to 1,1,1-trichloroethane.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The Environmental Protection Agency (EPA) sets regulations on the levels of 1,1,1-trichloroethane which are allowable in drinking water. The highest level of 1,1,1-trichloroethane allowed in drinking water is 0.2 ppm. The EPA has decided that the level of 1,1,1-trichloroethane in lakes and streams should not be more than 18 ppm. This level would prevent possible harmful health effects from drinking water and eating fish contaminated with 1,1,1-trichloroethane. Any releases or spills of 1,1,1-trichloroethane of 1,000 pounds or more must be reported to the National Response Center. 1,1,1-Trichloroethane levels in the workplace are regulated by the Occupational Safety and Health Administration (OSHA). The workplace exposure limit for an 8-hour workday, 40-hour workweek is 350 ppm in air. See Chapter 7 for more information on regulations and advisories regarding 1,1,1-trichloroethane.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR 1,1,2,2-TETRACHLOROETHANE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

August 1996

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about 1,1,2,2-tetrachloroethane and effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal clean-up. 1,1,2,2-Tetrachloroethane has been found in at least 273 of the 1,430 current or former NPL sites. However, it's not known how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with 1,1,2,2-tetrachloroethane may increase. This information is important because exposure to this substance may harm your and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to 1,1,2,2-tetrachloroethane, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, life-style, and state of health.

1.1 WHAT IS 1,1,2,2-TETRACHLOROETHANE?

1,1,2,2-Tetrachloroethane is a man-made, colorless, dense liquid that does not burn easily. It is volatile and has a penetrating, sweet odor similar to chloroform. Its production has decreased significantly in the United States. In the past it was used in large amounts to produce other chemicals and as an industrial solvent. 1,1,2,2-Tetrachloroethane was also used to separate other substances, to clean and degrease metals, and in paints and pesticides. Other chemicals are now available to replace this solvent, and large-scale commercial production has stopped. Its present use appears to be as a chemical intermediate, and information about this use is limited. For more information, see Chapters 3 and 4.

1.2 WHAT HAPPENS TO 1,1,2,2-TETRACHLOROETHANE WHEN IT ENTERS THE ENVIRONMENT?

Most 1,1,2,2-tetrachloroethane released into the environment eventually moves into the air or ground water. If released on the land, it does not tend to attach to soil particles. When released to surface water, much of the chemical will evaporate back to the air while the remainder may break down due to reactions with water. Similar reactions can take place in soils and sediments. Breakdown of this chemical in both the air and ground water is slow. Half of the chemical is expected to disappear from ground water in 13 months and from air in about 2 months. 1,1,2,2-Tetrachloroethane slowly degrades by losing chlorine atoms. The resulting chemicals are toxic to humans, perhaps even more toxic than the compound itself. It has been estimated that 1,1,2,2-tetrachloroethane should not build up significantly in the bodies of fish or other aquatic organisms. For more information, please see Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO 1,1,2,2-TETRACHLOROETHANE?

Low levels of 1,1,2,2-tetrachloroethane can be present in both indoor and outdoor air. Test studies of city areas show that it is present in only a small number of air samples. Its average concentration in city air could be as high as 57 parts per billion (ppb) (57 parts in 1 ,000,000,000 parts). In rural areas, air concentrations are much lower, typical levels being about 5 parts per trillion (ppt) (5 parts in 1,000,000,000,000 parts) or less. The average concentrations of 1,1,2,2-tetrachloroethane in the indoor air of several homes was 1.8 ppb. Because the air outside these homes did not contain measurable amounts of 1,1,2,2-tetrachloroethane the chemical appears to come from products used within these homes.

1,1,2,2-Tetrachloroethane can also be present in water. A comprehensive survey of representative samples of surface water and ground water, conducted in highly industrialized

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areas of New Jersey in 1977-79, found 6% of ground water samples and 11% of surface water samples contaminated with 1,1,2,2-tetrachloroethane. The highest levels found were 2.7 ppb in ground water and 3 ppb in surface water. The New Jersey survey included water supplies used for drinking and water not used for drinking. Although individuals may be exposed to 1,1,2,2-tetrachloroethane from contaminated drinking water, this rarely happens, at least in larger community drinking water systems. A nationwide survey of public drinking water systems that rely on underground sources did not find any supplies containing this pollutant. In a few instances, 1,1,2,2-tetrachloroethane has been found in private well water that may have been used for drinking. 1,1,2,2-Tetrachloroethane has not been reported in food or soil. It is not expected to build up in the food chain.

When a chemical such as 1,1,2,2-tetrachloroethane is used in making other chemicals, it is generally contained in closed automatic systems which are not open to the air. Therefore, workers are not usually exposed to high levels of 1,1,2,2-tetrachloroethane. A national survey conducted in 1981-83 estimated that 4,143 workers were exposed to 1,1,2,2-tetrachloroethane. However, the use of this chemical has decreased since 1983, so the number of exposed workers may now be much lower.

In addition to exposures in air and drinking water, people may be exposed to 1,1,2,2-tetrachloroethane from spills and other accidents or normal operations in workplaces. The compound has been used as a solvent for many operations. If you are exposed to such spills or involved in such work, you are most likely to be exposed by breathing in vapors of the chemical or from skin contact.

1,1,2,2-Tetrachloroethane was found in at least 273 of the 1,430 current or past hazardous waste sites on the National Priorities List (NPL). For more information, see Chapter 5.

1.4 HOW CAN 1,1,2,2-TETRACHLOROETHANE ENTER AND LEAVE MY BODY?

1,1,2,2-Tetrachloroethane can enter the body when a person breathes air containing the chemical or when the chemical comes into contact with a person's skin. If you accidentally drank water containing it, 1,1,2,2-tetrachloroethane would be absorbed into your body. 1,1,2,2-Tetrachloroethane is converted to more harmful products in animals and probably in humans. Most of it leaves the body within a few days through the breath or through the urine. For more information, see Chapter 2.

1.5 HOW CAN 1,1,2,2-TETRACHLOROETHANE AFFECT MY HEALTH?

1,1,2,2-Tetrachloroethane is not life-threatening unless you intentionally or accidentally drink more than a few spoonfuls at one time or spill a large amount so that you breathe it and get it on your skin. Breathing concentrated fumes of 1,1,2,2-tetrachloroethane (enough so that you notice its sickeningly sweet smell) can rapidly cause fatigue, vomiting, dizziness, and possibly unconsciousness. Most people recover from these effects once they are in fresh air. Breathing, drinking, or having 1,1,2,2-tetrachloroethane come into contact with your skin may cause liver damage, stomachaches, or dizziness if you are exposed long enough to high amounts. The health effects on people from long-term exposure to small amounts of 1,1,2,2-tetrachloroethane are not known.

It is not known whether 1,1,2,2-tetrachloroethane causes cancer in people. In a long-term study, 1,1,2,2-tetrachloroethane caused an increase in liver tumors in mice, but not in rats. The International Agency for Research on Cancer (IARC) has determined that 1,1,2,2-tetrachloroethane cannot be classified as to its ability to cause cancer in humans, while the Environmental Protection Agency (EPA) has determined that the chemical is a possible human carcinogen. Not enough information is available to determine whether exposure to the chemical will cause reproduction problems or birth defects in people. For more information on health effects, see Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,1,2,2-TETRACHLOROETHANE?

There are no specific medical tests to determine whether you have been exposed to 1,1,2,2-tetrachloroethane. The symptoms of 1,1,2,2-tetrachloroethane poisoning (stomach-

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aches, fatigue, and dizziness) are common to many diseases, and so these symptoms are not very useful in determining whether you were exposed to this particular chemical. 1 ,1,2,2-Tetrachloroethane can affect the liver and medical tests can determine whether the liver is working properly. However, liver disease may have many causes; therefore the presence of liver disease is not a reliable indicator for exposure to 1 ,1,2,2-tetrachloroethane. For more information, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The EPA has decided that no more than 0.17 micrograms of 1 ,1,2,2-tetrachloroethane per liter of water (or 0.17 ppb or less than 1 drop in a gallon) should be in lakes and streams. To protect workers during an S-hour shift, the U.S. Occupational Safety and Health Administration (OSHA) has set a limit of 1 parts per million (ppm) (1,000 ppb) of 1,1,2,2-tetrachloroethane in workroom air. The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) also recommend that the amount in workroom air be limited to 1 ppm in an 8- to I0-hour work shift.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
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TOXICOLOGICAL PROFILE FOR 1,1,2-TRICHLOROETHANE

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

In collaboration with:
U.S. Environmental Protection Agency

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1. PUBLIC HEALTH STATEMENT

1.1 WHAT IS 1,1,2-TRICHLOROETHANE

1,1,2-Trichloroethane is a colorless, sweet-smelling liquid that does not burn easily and boils at a higher temperature than water. It is made by two companies in the United States. It is used mostly where 1,1-dichloroethene (vinylidene chloride) is made. 1,1,2-Trichloroethane is used as a solvent. Because information about how much is made and how it is used is not available, we cannot say how much 1,1,2-trichloroethane is used, where it is used, or in what products it is found. 1,1,2-Trichloroethane may also be formed in landfills when 1,1,2,2-tetrachloroethane is broken down. When it is released into the environment, most 1,1,2-trichloroethane finally ends up in the air, but some may enter groundwater. Breakdown in both the air and groundwater is slow. In the air, half the 1,1,2-trichloroethane is expected to breakdown in 49 days and so it is likely to spread far from where it is released before breaking down. A few studies show that 1,1,2-trichloroethane below the soil surface or in groundwater does not breakdown within 16 weeks, and other studies suggest that it will last for years. Some studies show that breakdown of 1,1,2- trichloroethane occurs in landfills, but how fast this happens is not known. For more information, see Chapters 3, 4, and 5.

1.2 HOW MIGHT I BE EXPOSED TO 1,1,2-TRICHLOROETHANE?

Low levels of 1,1,2-trichloroethane may be found in outdoor air. The main source of this 1,1,2-trichloroethane is thought to be industries that use it as a solvent. Because the industries that produce 1,1,2-trichloroethane or use it to make other chemicals often recycle or burn their waste, releases of 1,1,2-trichloroethane by these industries should not be major sources of pollution. From surveys of industrial wastewater, we learn that some of the industries that discharge 1,1,2-trichloroethane are the timber products industry, plastics and synthetics industry, and laundries. Limited data show that 1,1,2-trichloroethane is present in a quarter to a half of city air samples. Where 1,1,2-trichloroethane is found, the samples tested usually contain 10 to 50 parts of 1,1,2-trichloroethane per trillion parts of air (ppt). Though exposure to contaminated drinking water taken from groundwater sources is possible, such exposure appears to be rare. A nationwide survey did not find 1,1,2-trichloroethane in drinking water, but well water in some areas has been found to contain it. Surveys found 1,1,2-trichloroethane in well water in Wisconsin, New Jersey, Rhode Island, and Suffolk County, New York. The largest amount in these supplies was 31 parts of 1,1,2-trichloroethane per one billion parts of water (ppb). 1,1,2-Trichloroethane has not been reported in food or soil. Besides the air and drinking water sources, people may be exposed to 1,1,2-trichloroethane from spills and in the workplace, where it may be used as a solvent. Exposure would most likely be from breathing vapors of the chemical or from skin contact. When a chemical like 1,1,2-trichloroethane is utilized to make other chemicals, it is usually used in tightly closed automatic systems, so that workers are not usually exposed to high levels of it. A national survey conducted in 1981-1983 estimated that 1,036 workers were exposed to 1,1,2-trichloroethane. 1,1,2-Trichloroethane has been found thus far at 45 of 1177 hazardous waste sites on the National Priorities List (NPL) in the United States. Landfill gases from these sites may contain 1,1,2-trichloroethane. For more information, please see Chapter 5.

1.3 HOW CAN 1,1,2-TRICHLOROETHANE ENTER AND LEAVE MY BODY?

1,1,2-Trichloroethane can enter the body when a person breathes air containing 1,1,2-trichloroethane, or when a person drinks water containing this compound. It can also enter the body through the skin. After it enters the body, it is carried by the blood to organs and tissues such as the liver, kidney, brain, heart, spleen, and fat. Experiments in which animals were given 1,1,2-trichloroethane by mouth have shown that most 1,1,2-trichloroethane leaves the body unchanged in the breath and as other substances that it was changed into in the urine in about 1 day. Very little stays in the body more than 2 days. More information on how 1,1,2-trichloroethane can enter and leave the body can be found in Chapter 2.

1.4 HOW CAN 1,1,2-TRICHLOROETHANE AFFECT MY HEALTH?

1,1,2-Trichloroethane can cause temporary stinging and burning pain on the skin when humans touch it. There is no other information on the health effects of 1,1,2-trichloroethane in humans. Most of what we know about the health effects of this chemical comes from experiments in animals. As is true with most chemicals, a large amount of 1,1,2-trichloroethane produces more damage than a small amount. Short-term exposure to high levels of 1,1,2-trichloroethane in air or high doses given by mouth or applied to the skin has caused death in animals. Long-term exposure of animals to high doses given by mouth has also shortened the lifespan. These levels and doses are much higher than would be found in the air, water, or food to which humans might be exposed. Breathing high levels in air can affect the nervous system and cause sleepiness. 1,1,2-Trichloroethane may also affect the liver, kidney, and digestive tract, produce skin irritation, and affect the body's ability to fight infections. Mice, but not rats, that were given high doses of 1,1,2-trichloroethane by mouth for most of their life developed liver cancer, but we do not know whether humans exposed to this chemical would develop cancer. From the limited information available in animals, it appears that 1,1,2-trichloroethane does not cause birth defects or otherwise inhibit normal development. More information on the health effects of 1,1,2-trichloroethane can be found in Chapter 2.

1.5 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,1,2-TRICHLOROETHANE?

Although chemists have ways of measuring some chemicals in body fluids, there is no commonly used medical test to find out whether a person has been exposed to 1,1,2-trichloroethane.

1.6 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Tables 1-1, 1-2, 1-3, and 1-4 show the link between exposure to 1,1,2-trichloroethane and known health effects. Tables 1-1 and 1-3 show that no information is available on human health effects from breathing, eating, or drinking 1,1,2-trichloroethane. Minimal Risk Levels (MRLs) are included in Table 1-3. These MRLs were derived from animal data for both short- and long-term exposure, as described in Chapter 2 and in Table 2-2. The MRLs provide a basis for comparison to levels which people might encounter either in the air or in food or drinking water. If a person is exposed to 1,1,2-trichloroethane at an amount below the MRL, it is not expected that harmful (noncancer) health effects will occur. Since these levels are based on information that is currently available, there is always some uncertainty associated with it. Also since the method for deriving MRLs does not use any information about cancer, an MRL does not imply anything about the presence, absence, or level of risk of cancer. In Table 1-2, death is reported to occur at levels that are less than or equal to the levels that cause central nervous system depression and mild liver effects. However, the period of exposure that produces death is longer. More information on levels of exposure linked with harmful effects can be found in Chapter 2.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The Environmental Protection Agency (EPA) has allowed a limit of 0.6 μg/L (ppb) 1,1,2-trichloroethane in waters such as lakes and streams. The EPA also requires industry to report discharges or spills of 100 or more Pounds.

Levels of 1,1,2-trichloroethane allowed in the workplace are regulated by the Occupational Safety and Health Administration (OSHA). The occupational exposure limit is 10 parts of 1,1,2-trichloroethane per one million parts of air (ppm) for an 8-hour workday, 40-hour workweek. More information on government recommendations can be found in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have more questions or concerns, please contact your state health or environmental department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

TABLE 1-1. Human Health Effects from Breathing 1,1,2-Trichloroethane*

Levels in Air (ppm)	Length of Exposure	Description of Effects
Short-term Exposure (less than or equal to 14 days)		
		The health effects resulting from short-term human exposure to air containing specific levels of 1,1,2-trichloroethane are not known.
Long-term Exposure (greater than 14 days)		
		The health effects resulting from long-term human exposure to air containing specific levels of 1,1,2-trichloroethane are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-2. Animal Health Effects from Breathing 1,1,2-Trichloroethane

Short-term Exposure (less than or equal to 14 days)		
Levels in Air (ppm)	**Length of Exposure**	**Description of Effects***
416	6 hr	Death in mice.
418	4 hr	Central nervous system depression in mice.
500	8 hr	Death in rats.
800	3 hr	Liver effects in mice.
Long-term Exposure (greater than 14 days)		
Levels in Air (ppm)	**Length of Exposure**	**Description of Effects**
		The health effects resulting from long-term animal exposure to air containing specific levels of 1,1,2-trichloroethane are not known.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at the higher levels.

TABLE 1-3. Human Health Effects from Eating or Drinking 1,1,2-Trichloroethane*

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from short-term human exposure to air containing specific levels of 1,1,2-trichloroethane are not known.
Levels in Water (ppm)		
10.5		Minimal risk level (derived from animal data; see Section 1.6 for discussion).
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from long-term human exposure to food containing specific levels of 1,1,2-trichloroethane are not known.
Levels in Water (ppm)		
1.4		Minimal risk level (derived from animal data; see Section 1.6 for discussion).

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-4. Animal Health Effects from Eating or Drinking 1,1,2-Trichloroethane

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
1200	1 day	Liver effects in rats.
Levels in Water (ppm)		
525	1 day	Taste aversion in mice.
670	1 day	Motor impairment in mice
1990	1 day	Death in mice.
5980	1 day	Death in rats.
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
1500	78 weeks	Shortened lifespan in mice.
Levels in Water (ppm)		
200	90 days	Immune system effects in mice.
200	90 days	Liver effects in mice.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

TOXICOLOGICAL PROFILE FOR 1,1-DICHLOROETHANE

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

December 1990

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about l,l-dichloroethane and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,177 sites on its National Priorities List (NPL). l,l-Dichloroethane has been found at 189 of these sites. However, we do not know how many of the 1,177 NPL sites have been evaluated for l,l-dichloroethane. As EPA evaluates more sites, the number of sites at which l,l-dichloroethane is found may change. The information is important for you because l,l-dichloroethane may cause harmful health effects and because these sites are potential or actual sources of human exposure to l,l-dichloroethane.

When a chemical is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous substance such as l,l-dichloroethane several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

1.1 WHAT IS l,l-DICHLOROETHANE?

l,l-Dichloroethane is a colorless, oily, man-made liquid. It evaporates quickly at room temperature and has an odor like ether. l,l-Dichloroethane burns easily. When l,l-dichloroethane is released to the environment, it usually exists as a vapor rather than a liquid. It is used primarily to make l,l,l-trichloroethane and a number of other chemicals. It is also used to dissolve other substances such as paint, varnish and finish removers, and to remove grease. l,l-Dichloroethane was used as a surgical anesthetic, but is no longer.

Almost all of the l,l-dichloroethane from industrial sources that is released goes into the air. l,l-Dichloroethane can also be found in the environment as a breakdown product of l,l,l-trichloroethane in landfills where no air comes in contact with the l,l,l-trichloroethane. l,l-Dichloroethane does not dissolve easily in water. The small amounts released to water can evaporate easily into the air. l,l-Dichloroethane remains as a vapor in the air for about 2 months and dissolved in water for about 5 days. The vapor in air can be washed out by rain or broken down by sunlight. l,l-Dichloroethane in water will evaporate. Small amounts of l,l-dichloroethane released to soil can also evaporate into the air or move through the soil to enter groundwater. It is not known how long l,l-dichloroethane remains in the soil. Although it does not dissolve easily in water, low levels can be found in water.

More information on the chemical and physical properties of l,l-dichloroethane can be found in Chapter 3, on its production and uses in Chapter 4, and on its occurrence and fate in the environment in Chapter 5.

1.2 HOW MIGHT I BE EXPOSED TO 1,1-DICHLOROETHANE?

You can be exposed to l,l-dichloroethane by breathing air containing its vapors in the outdoor air or in your workplace, or by drinking water contaminated with it. Releases from industrial processes are the main source of this chemical in the air. Some members of the general population may be exposed to low levels of l,l-dichloroethane from this source (0.08-0.14 parts per billion [l part l,l-dichloroethane per 1 billion parts of air, or ppb]). Levels in . this range have been measured around industrial plants in Magna, Utah (0.082 ppb); Iberville, Louisiana (0.12 ppb); Deer Park, Texas (0.14 ppb); and Baton Rouge (0.058 ppb) and Geismary, Louisiana (0.14 ppb). You may be part of a much smaller population of workers who could be exposed to higher levels of l,l-dichloroethane in your workplace, if you are employed in the chemical, rubber and plastic, electrical, or oil and gas industries. However, since current levels of production and use are not known, it is difficult to predict how often exposure might occur from these sources of l,l-dichloroethane. Exposure can also occur near sites where the chemical was improperly disposed of or spilled on the ground.

The average concentration of l,l-dichloroethane in the air across the United States is reported to be 55 parts of l,l-dichloroethane per one trillion parts of air (ppt). These ambient levels may be from chlorinated water or building materials. The air levels of l,l-dichloroethane are usually lower in rural areas and higher in industrialized areas. Higher levels have been found in the air around some small sources of release, such as hazardous waste sites. l,l-Dichloroethane has been found in drinking water (that is, water that has usually been treated and that comes out of your tap) in the United States at levels that range from trace amounts to 4.8 parts of l,l-dichloroethane per one billion parts of water (ppb). l,l-Dichloroethane has not been detected in any surface water samples from rivers, lakes, or ponds. No information is available on background levels of l,l-dichloroethane in soil or food.

Additional information on the levels of l,l-dichloroethane in the environment and human exposure to l,l-dichloroethane can be found in Chapter 5.

1.3 HOW CAN 1,1-DICHLOROETHANE ENTER AND LEAVE MY BODY?

1,1-Dichloroethane can enter your body if you breathe contaminated air or drink contaminated water. 1,1-Dichloroethane is believed to rapidly enter your body when it is breathed or swallowed. It is not known what factors affect how quickly 1,1-dichloroethane enters your body. Studies in animals show that it is likely that 1,1-dichloroethane can also enter your body through your skin.

The most common way you could be exposed to 1,1-dichloroethane released from hazardous waste sites would be by breathing contaminated air around the site. Soil and water in and around hazardous waste sites are not likely to contain high concentrations of 1,1-dichloroethane because it escapes quickly into the air. Therefore, though this route of exposure cannot be ruled out completely, exposure of the skin from soil or water contaminated with 1,1-dichloroethane is much less likely.

Experiments in animals indicate that the 1,1-dichloroethane that is inhaled or swallowed may go to many organs of the body, depending on the amount taken in. However, most of the 1,1-dichloroethane taken in is usually removed unchanged from the body in the breath within 2 days. A small part of the 1,1-dichloroethane taken in is broken down, and these breakdown products are quickly removed in the breath or urine.

Additional information on how 1,1-dichloroethane can enter and leave the body is presented in Chapter 2.

1.4 HOW CAN 1,1-DICHLOROETHANE AFFECT MY HEALTH?

Reliable information on how 1,1-dichloroethane affects the health of humans is not available. Because brief exposures to 1,1-dichloroethane in the air at very high levels have caused death in animals (16,000 ppm), it is likely that exposure to such high levels of 1,1-dichloroethane in the air can also cause death in humans. Some studies in animals have shown that 1,1-dichloroethane can cause kidney disease after long-term, high-level exposure in the air. 1,1-Dichloroethane caused cancer in animals given very high doses (over 3,000 mg/kg/day) by mouth for a lifetime. Delayed growth was observed in the offspring of animals who breathed high concentrations of 1,1-dichloroethane during pregnancy. The severity of these effects may increase when people or animals are exposed to increased levels of 1,1-dichloroethane. Since these effects were seen in animals at high doses, it is also possible that they could occur in humans exposed to high levels of 1,1-dichloroethane. However, we have no information to indicate that these effects do occur in humans. More information on health effects associated with exposure to 1,1-dichloroethane can be found in Chapter 2.

1.5 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

There is no reliable information on what levels of exposure to l,l-dichloroethane have resulted in harmful health effects in humans. l,l-Dichloroethane is deadly to animals if large enough quantities are breathed or swallowed. Tables l-1 through l-4 show the relationship between exposure to l,l-dichloroethane and known health effects in humans and animals. l,l-Dichloroethane can be smelled when it is present in the air at levels of 120 to 200 parts of l,l-dichloroethane per one million parts of air (ppm).

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO l,l-DICHLOROETHANE?

Tests are available that measure l,l-dichloroethane in urine, blood, breath and body tissues. Because urine, blood, and breath samples are easily obtained, these samples are examined to determine if a person has been exposed to l,l-dichloroethane. These tests are not routinely available at a doctor's office and would require special equipment for sampling and detection of the compound. Since most of the l,l-dichloroethane that is taken into the body leaves within two days, these tests must be done soon after exposure occurs. Although these tests can confirm that a person has been exposed to l,l-dichloroethane, it is not yet possible to use the test results to predict the type or severity of any health effects that might occur or the level of exposure that may have occurred. Because exposure to l,l-dichloroethane at hazardous waste sites is likely to include exposure to other similar chemicals at the same time, levels of l,l-dichloroethane measured through these types of medical tests may not reflect exposure to l,l-dichloroethane alone. Information regarding tests for the detection of 1,1-dichloroethane in the body is presented in Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

There are no regulatory standards or advisories for l,l-dichloroethane in drinking water and food. The Environmental Protection Agency (EPA) has determined that any release to the environment in excess of 1,000 pounds should be reported.

Rules and regulations have been developed to protect individuals from the potential health effects of l,l-dichloroethane in air. The American Conference of Governmental Industrial Hygienists (ACGIH) has set a threshold limit value (TLV) of 810 mg/m^3 (200 ppm) l,l-dichloroethane in workroom air to protect workers during an S-hour shift over a 40-hour work week. The Occupational Safety and Health Administration (OSHA) has issued a permissible exposure limit (PEL) of 400 mg/m^3 (98.9 ppm).

For more information on criteria and standards for l,l-dichloroethane exposure, see Chapter 7.

TABLE 1-1. Human Health Effects from Breathing 1,1-Dichloroethane*

Short-term Exposure (less than or equal to 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of humans to air containing specific levels of 1,1-dichloroethane are not known.
Long-term Exposure (greater than 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from long-term exposure of humans to air containing specific levels of 1,1-dichloroethane are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-2. Animal Health Effects from Breathing 1,1-Dichloroethane

Short-term Exposure (less than or equal to 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects*
1,750	10 days	Birth defects in rats.
Long-term Exposure (greater than 14 days)		
Levels in Air (ppm)	Length of Exposure	Exposure of Effects*
		The health effects resulting from long-term exposure of animals to air containing specific levels of 1,1-dichloroethane are not known.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

TABLE 1-3. Human Health Effects from Eating or Drinking 1,1-Dichloroethane*

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of humans to food containing specific levels of 1,1-dichloroethane are not known.
Levels in Water (ppm)		
		The health effects resulting from short-term exposure of humans to water containing specific levels of 1,1-dichloroethane are not known.
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from long-term exposure of humans to food containing specific levels of 1,1-dichloroethane are not known.
Levels in Water (ppm)		
		The health effects resulting long-term exposure of humans to water containing specific levels of 1,1-dichloroethane are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-4. Animal Health Effects from Eating or Drinking 1,1-Dichloroethane

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of animals to food containing specific levels of 1,1-dichloroethane are not known.
Levels in Water (ppm)		
		The health effects resulting from short-term exposure of animals to water containing specific levels of 1,1-dichloroethane are not known.
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
7,640	2 years	Death in rats.
9,500	2 years	Cancer in rats.
Levels in Water (ppm)		
		The health effects resulting from long-term exposure of animals to water containing specific levels of 1,1-dichloroethane are not known.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns not covered here, please contact your State Health or Environmental Department or:

Agency for Toxic Substances and Disease Registry.
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

This agency can also give you information on the location of the nearest occupational and environmental health clinics. Such clinics specialize in the recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR 1,1-DICHLOROETHENE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

May 1994

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about 1,1-dichloroethene and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,350 hazardous waste sites as the most serious in the nation. These sites comprise the "National Priorities List" (NPL): Those sites which are targeted for long-term federal cleanup activities. 1,1-dichloroethene has been found in at least 492 of the sites on the NPL. However, the number of NPL sites evaluated for 1,1-dichloroethene is not known. As EPA evaluates more sites, the number of sites at which 1,1-dichloroethene is found may increase. This information is important because exposure to 1,1-dichloroethene may cause harmful health effects and because these sites are potential or actual sources of human exposure to 1,1-dichloroethene.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to a substance such as 1,1-dichloroethene, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, gender, nutritional status, family traits, life-style, and state of health.

1. PUBLIC HEALTH STATEMENT

1.1 WHAT IS 1,1-DICHLOROETHENE?

1,1-dichloroethene, also known as vinylidene chloride, is a chemical used to make certain plastics (such as packaging materials, flexible films like SARAN wrap) and flameretardant coatings for fiber and carpet backing. It is a colorless liquid that evaporates quickly at room temperature. It has a mild sweet smell and burns quickly.

1,1-dichloroethene is a man-made chemical and is not found naturally in the environment. Although 1,1-dichloroethene is manufactured in large quantities, most of it is used to make other substances or products such as polyvinylidene chloride. For information on the chemical and physical properties and use of 1,1-dichloroethene, see Chapters 3 and 4.

1.2 WHAT HAPPENS TO 1,1-DICHLOROETHENE WHEN IT ENTERS THE ENVIRONMENT?

1,1-dichloroethene can enter the environment when it is released to the air during its production or released to surface water or soil as a result of waste disposal. Most 1,1-dichloroethene evaporates quickly and mainly enters the environment through the air, although some enters into rivers or lakes. 1,1-dichloroethene can enter soil, water, and air in large amounts during an accidental spill. 1,1-dichloroethene can also enter the environment as a breakdown product of other chemicals in the environment.

1,1-dichloroethene behaves differently in air, water, and soil. 1,1-dichloroethene evaporates to the air very quickly from soil and water. In the air, 1,1-dichloroethene is broken down by reactive compounds formed by sunlight. 1,1-dichloroethene remains in the air for about 4 days.

From water, 1,1-dichloroethene evaporates into the air; it breaks down very slowly in water. We do not know exactly how long 1,1-dichloroethene stays in water. It is not readily transferred to fish or birds, and only very small amounts enter the food chain.

In soil, 1,1-dichloroethene either evaporates to the air or percolates down through soil with rainwater and enters underground water. Small living organisms in soil and groundwater may transform it into other less harmful substances, although this happens slowly.

More information on what happens to 1,1-dichloroethene in the environment can be found in Chapter 5.

1.3 HOW MIGHT I BE EXPOSED TO 1,1-DICHLOROETHENE?

You may be exposed to 1,1-dichloroethene by breathing it when it is in the air or eating food or water that contains it. You may also be exposed to 1,1-dichloroethene if it touches your skin. 1,1-dichloroethene is found at very low levels in indoor and outdoor air (estimated as less than 1 part per trillion parts of air [ppt]). Therefore, the potential for exposure in the environment is extremely low. The amounts are somewhat higher near some factories that make or use 1,1-dichloroethene (those that make foodpackaging films, adhesives, flame-retardant coatings for fiber and carpet backing, piping, and coating for steel pipes), hazardous waste sites, and areas near accidental spills. The exact amount of 1,1-dichloroethene in the air near these factories is not known. In air around waste sites where it has been identified, the amount of 1,1-dichloroethene ranges from 0.39 to 97 parts 1,1-dichloroethene per billion parts of air (ppb, 1 ppb is 1,000 times more than 1 ppt). The levels of 1,1-dichloroethene in air around waste sites are usually much lower than those that have caused health effects in animals. We estimate that 1,1-dichloroethene contaminates the air around 97 chemical factories in the United States. Factories that make 1,1-dichloroethene are mainly located in Texas and Louisiana. Measured air levels inside manufacturing plants range from less than 5 to 1900 parts 1,1-dichloroethene per million parts of air (ppm, 1 ppm is 1,000 times more than 1 ppb).

A small percentage (3%) of the drinking water sources in the United States contain low amounts of 1,1-dichloroethene (0.2-0.5 ppb with an estimated average of 0.3 ppb). The amounts are very low compared with levels that are expected to affect human health. The concentration of 1,1-dichloroethene in groundwater samples from hazardous waste sites ranged from 0.001 to 0.09 ppm.

Since 1,1-dichloroethene is used to make some ccmsumer products, exposure might occur while these products are made or used. For example, the estimated average amount of 1,1-dichloroethene in plastic food-packaging films ranged from <0.02 to 1.26 ppm. The measured average amount in food wrapped in these films was less than 0.01 ppm. Not every tested food sample contained 1,1-dichloroethene, so these numbers only reflect the levels found in food samples tested that did contain 1,1-dichloroethene. The Food and Drug Administration (FDA) regulates the use of plastic packaging films. The FDA has determined that the films can contain no more than 10 ppm 1,1-dichloroethene and that the low levels of 1,1-dichloroethene found in food wrapped in these films present no health risk to the consumer. Besides environmental exposures, occupational exposure can occur for workers who are involved in the manufacture and use of 1,1-dichloroethene. These workers include primarily carpenters, warehouse workers, and machine operators. More information on human exposure can be found in Chapter 5.

1.4 HOW CAN 1,1-DICHLOROETHENE ENTER AND LEAVE MY BODY?

1,1-dichloroethene can easily enter the body through the lungs as an air pollutant or through the stomach and intestines if you eat or drink contaminated food or water. Based on the physical and chemical properties of 1,1-dichloroethene, we think that 1,1-dichloroethene can also enter the body through the human skin. Harmful effects have occurred in animals after 1,3-dichloroethene was applied to their skin.

Animal studies indicate that following exposure, 1,1-dichloroethene partly leaves the body through the lungs. The remaining 1,1-dichloroethene breaks down into other substances that leave the body in the urine within 1-2 days. Some of the breakdown products of 1, 1-dichloroethene such as dithioglycolic acid, are more harmful than 1, 1-dichloroethene. The way 1,1-dichloroethene and its breakdown products leave the body depends on the amount of 1,1-dichloroethene that enters the body. Low or moderate levels breathed in (25-200 ppm) or taken by mouth (up to 50 milligrams per kilogram of body weight) leave the body mainly as breakdown products in the urine. As the amount of 1,1-dichloroethene that enters the body increases, more and more 1,1-dichloroethene leaves the body in the exhaled breath. Whether 1,1-dichloroethene is inhaled or taken by mouth it leaves the body in about the same way. 1,1-dichloroethene is not stored very much in the body when low-to-moderate amounts enter the body. More information on how 1,1-dichloroethene enters and leaves the body is found in Chapter 2.

1.5 HOW CAN 1,1-DICHLOROETHENE AFFECT MY HEALTH?

How a chemical affects your health depends on how much you are exposed to and for how long. As the level and length of your exposure increase, the effects are likely to become more severe. Information on the health effects in humans after breathing 1,1-dichloroethene is insufficient. People who breathed high amounts of 1,1-dichloroethene in a closed space lost their breath and fainted. Some people who breathed 1,1-dichloroethene at work for several years had abnormal liver function. However, exposure to other chemicals may have also contributed to this effect. Available information indicates that prolonged inhalation of 1,1-dichloroethene can induce adverse neurological effects and is possibly associated with liver and kidney damage in humans. Studies in animals indicate that 1,1-dichloroethene can affect the normal functions of the liver, kidneys, and lungs. However, the amount of 1,1-dichloroethene in the air to which the animals were exposed was much higher than the amounts in the air that the general public usually breathes. Some animals that breathed large amounts of 1,1-dichloroethene died within a few days. The liver and kidneys of animals were affected after breathing air that contained 1,1-dichloroethene for days, months, or years. After pregnant rats breathed 1,1-dichloroethene in air, some of the newborn rats had birth defects.

We have no information on health effects in humans who ate food or drank water that contained 1,1-dichloroethene. Animals fed food that contained 1,1-dichloroethene or that had 1,1-dichloroethene placed experimentally in their stomachs developed liver and kidney disease, and some even died. These amounts, however, were very much higher than those which occur in drinking water supplies. Birth defects did not occur in the newborn of female rats that drank 1,1-dichloroethene.

Spilling 1,1-dichloroethene on your skin or in your eyes can cause irritation. We do not know what other health effects might occur if 1,1-dichloroethene comes into contact with your skin for long periods. However, no serious effects or deaths occurred in mice after small amounts of 1,1-dichloroethene were put on their skin over a period of months. We do not know whether spilling 1,1-dichloroethene on your skin can cause birth defects or affect fertility.

We do not know whether coming into contact with 1,1-dichloroethene increases the risk of cancer in humans. Evidence from epidemiology studies of workers exposed to 1,1-dichloroethene is inconclusive. Several studies examined the possibility that 1,1-dichloroethene may increase the risk of cancer in animals. Only one of these studies indicated that mice breathing 1,1-dichloroethene for 1 year developed kidney cancer, but the particular type of mouse used may be especially sensitive to 1,1-dichloroethene. The U.S. Department of Health and Human Services has not classified 1,1-dichloroethene

with respect to carcinogenicity. The International Agency for Research on Cancer (IARC) has determined that 1,1-dichloroethene is not classifiable as to its carcinogenicity in humans. The EPA has determined that 1,1-dichloroethene is a possible human carcinogen. NTP does not include it in its list of substances expected to be human carcinogens.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,1-DICHLOROETHENE?

1,1-dichloroethene can be measured in the breath, blood, urine, and body tissues of individuals who come in contact with the chemical. However, only relatively high levels of 1,1-dichloroethene in body tissues and fluids can be measured. Because breath samples are easily collected, tests of exhaled air are now the most common way to tell whether a person has been exposed to high levels of 1,1-dichloroethene. One of the breakdown products of 1,1-dichloroethene, dithioglycolic acid, can also be measured in urine. None of these tests are regularly available at a doctor's office because they require special equipment, but your doctor can tell you where you can get the tests done. Although these tests can prove that a person has been exposed to 1,1-dichloroethene, they cannot tell if any health effects will occur. Since most of the 1,1-dichloroethene leaves the body within a few days, these methods are best for determining whether exposures have occurred within the last several days. Detection of 1,1-dichloroethene or its breakdown products in the body may not necessarily mean that exposure to 1,1-dichloroethene alone has occurred. People exposed to 1,1-dichloroethene at hazardous waste sites were probably also exposed to other organic compounds, that produce breakdown products similar to those of 1,1-dichloroethene. Other methods for measuring the effects associated with exposure to 1,1-dichloroethene (such as reduced enzyme levels) are not specific enough to detect effects caused by exposure to 1,l -dichloroethene alone. More information on the available tests for detecting 1,1-dichloroethene in the body is found in Chapter 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has developed regulatory guidelines and standards to protect people from the possible health effects of 1,1-dichloroethene. The Occupational Safety and Health Administration (OSHA) requires workplace exposure limits of 1 ppm or less for an 9-hour workday to protect workers from noncancer harmful health effects. To guarantee the maximum protection for human health from the possible cancer effects of drinking water or eating seafood (fish or shellfish) that contain over a 1,1-dichloroethene lifetime, the EPA recommends that the level of 1,1-dichloroethene in lakes and streams should not exceed 0.003 ppm. EPA has determined that drinking water containing 3.5 ppm of 1,1-dichloroethene for adults and 1 ppm for children is not expected to cause noncancerous harmful health effects. The National Institute for Occupational Safety and

Health (NIOSH) has recommended that 1,1-dichloroethene is a potential occupational cancer causing chemical.

The EPA limits the amount of 1,1-dichloroethene permitted in publicly owned waste water treatment plants. To minimize human exposure to 1,1-dichloroethene, EPA requires that industry tell the National Response Center when 100 pounds or more of 1,1-dichloroethene have been released in the environment.

For more information on federal and state recommendations, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
(404) 498-0160

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR 1,2-DICHLOROETHANE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 2001

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about 1,2-dichloroethane and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. 1,2-Dichloroethane has been found in at least 570 of the 1,585 current or former NPL sites. However, the total number of NPL sites evaluated for 1,2-dichloroethane is not known. As more sites are evaluated, the sites at which 1,2-dichloroethane is found may increase. This information is important because exposure to 1,2-dichloroethane may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to 1,2-dichloroethane, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS 1,2-DICHLOROETHANE?

1,2-Dichloroethane is a clear, manufactured liquid that is not found naturally in the environment. It evaporates quickly at room temperature and has a pleasant smell and a sweet taste. 1,2-Dichloroethane burns with a smoky flame. At this time, the most common use of 1,2-dichloroethane is to make vinyl chloride, which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes and other important construction materials, packaging materials, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. 1,2-Dichloroethane is also used as a solvent and is added to leaded gasoline to remove lead. In the past, it was also found in small amounts in products that industries used to clean cloth, remove grease from metal, and break down oils, fats, waxes, resins, and rubber. In the household, 1,2-dichloroethane was formerly a component of some cleaning solutions and pesticides; some adhesives, such as those used to glue wallpaper or carpeting; and some paint, varnish, and finish removers. Although large amounts of 1,2-dichloroethane are produced today, most is used to make other chemical products.

Small amounts of 1,2-dichloroethane that were released into water or soil evaporate into the air. 1,2-Dichloroethane that remains in soil from a spill or improper disposal can travel through the ground into water. The chemical may remain in water or soil for more than 40 days.

Chapter 4 contains more chemical and physical information about 1,2-dichloroethane. Chapter 5 has more information on its uses, and Chapter 6 tells about its presence in the environment.

1.2 WHAT HAPPENS TO 1,2-DICHLOROETHANE WHEN IT ENTERS THE ENVIRONMENT?

1,2-Dichloroethane can enter the environment when it is made, packaged, shipped, or used. Most 1,2-dichloroethane is released to the air, although some is released to rivers or lakes. 1,2-Dichloroethane could also enter soil, water, or air in large amounts in an accidental spill.

1,2-Dichloroethane evaporates into the air very fast from soil and water. In the air, it breaks down by reacting with other compounds formed by the sunlight. 1,2-Dichloroethane will stay in the air for more than 5 months before it is broken down. It may also be removed from air in rain or snow. Since it stays in the air for a while, the wind may carry it over large distances.

In water, 1,2-dichloroethane breaks down very slowly and most of it will evaporate to the air. Only very small amounts are taken up by plants and fish. We do not know exactly how long 1,2-dichloroethane remains in water, but we do know that it remains longer in lakes than in rivers.

In soil, 1,2-dichloroethane either evaporates into the air or travels down through soil and enters underground water. Small organisms living in soil and groundwater may transform it into other less harmful compounds, although this happens slowly. If a large amount of 1,2-dichloroethane enters soil from an accident, hazardous waste site, or landfill, it may travel a long way underground and contaminate drinking water wells.

More information on what happens to 1,2-dichloroethane in the environment can be found in Chapters 5 and 6.

1.3 HOW MIGHT I BE EXPOSED TO 1,2-DICHLOROETHANE?

Humans are exposed to 1,2-dichloroethane mainly by breathing air or drinking water that contains 1,2-dichloroethane. Human exposure usually happens where the chemical has been improperly disposed of, or spilled onto the ground. However, low levels of 1,2-dichloroethane have also been found in the air near industries where it is made or used in manufacturing. Humans can be exposed to low levels of 1,2-dichloroethane through the skin or air by contact with old products made with 1,2-dichloroethane, such as cleaning agents, pesticides, and adhesives used to glue wallpaper and carpets. Such exposure is probably not enough to cause harmful health effects.

1,2-Dichloroethane has been found in U.S. drinking water at levels ranging from 0.05 to 64 parts of 1,2-dichloroethane per billion (ppb) parts of water. An average amount of 175 ppb has been found in 12% of the surface water and groundwater samples taken at 2,783 hazardous wastes sites. 1,2-Dichloroethane has also been found in the air near urban areas at levels of 0.10–1.50 ppb and near hazardous waste sites at levels of 0.01–0.003 ppb. Small amounts of 1,2-dichloroethane have also been found in foods.

Humans may also be exposed to 1,2-dichloroethane through its use as a gasoline additive to reduce lead content, but these small levels are not expected to affect human health. This is probably not an important way that people are exposed to 1,2-dichloroethane in the United States, since leaded gasolines are rarely used today.

Additional information on levels in the environment and potential for human exposure are presented in Chapter 6.

1.4 HOW CAN 1,2-DICHLOROETHANE ENTER AND LEAVE MY BODY?

1,2-Dichloroethane can enter the body when people breathe air or drink water that contains 1,2-dichloroethane. Studies in animals also show that 1,2-dichloroethane can enter the body through the skin. Humans are most likely to be exposed at work and outside the workplace by drinking water that contains 1,2-dichloroethane, or by breathing 1,2-dichloroethane that has escaped from contaminated water or soil into the air.

Experiments in animals show that 1,2-dichloroethane that is breathed in or swallowed goes to many organs of the body, but usually leaves in the breath within 1 or 2 days. The breakdown products of 1,2-dichloroethane in the body leave quickly in the urine. Soil near hazardous waste sites probably does not have high amounts of 1,2-dichloroethane because it evaporates quickly into the air. This suggests that exposure near a hazardous waste site would most likely occur by breathing contaminated air rather than by touching contaminated soil.

Further information on how 1,2-dichloroethane can enter and leave the body is presented in Chapter 3.

1.5 HOW CAN 1,2-DICHLOROETHANE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

People who were accidentally exposed to large amounts of 1,2-dichloroethane in the air or who swallowed 1,2-dichloroethane by accident or on purpose often developed nervous system disorders and liver and kidney disease. Lung effects were also seen after a large amount of 1,2-dichloroethane was inhaled. People often died from heart failure. We do not know what levels of 1,2-dichloroethane caused these effects, but they are probably high. Studies in laboratory animals also found that breathing or swallowing large amounts of 1,2-dichloroethane produced nervous system disorders, kidney disease, or lung effects. Reduced ability to fight infection was also seen in laboratory animals who breathed or swallowed 1,2-dichloroethane, but we do not know if this also occurs in humans. Longer-term exposure to lower doses also caused kidney disease in animals.

So far, exposure to 1,2-dichloroethane has not been associated with cancer in humans. One study showed a relationship between increased cancer and exposure to pollutants in groundwater, including 1,2-dichloroethane, but the people were probably exposed to many other chemicals at the same time. Cancer was found in laboratory animals who were fed large doses of 1,2-dichloroethane. When 1,2-dichloroethane was put on the skin of laboratory animals, they developed lung tumors. We are not sure whether breathing 1,2-dichloroethane causes cancer in animals. Because of the cancer findings in animals, the possibility of cancer in humans cannot be ruled out. The Department of Health and Human Services (DHHS) has determined that 1,2-dichloroethane may reasonably be expected to cause cancer. The International Agency for Research on Cancer (IARC) has determined that 1,2-dichloroethane can possibly cause cancer in humans. EPA has determined that 1,2-dichloroethane is a probable human carcinogen.

Additional information regarding the health effects of 1,2-dichloroethane can be found in Chapter 3.

1.6 HOW CAN 1,2-DICHLOROETHANE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children can be exposed to 1,2-dichloroethane by breathing contaminated air, and possibly by drinking contaminated water. In the past, 1,2-dichloroethane had been used in certain household items, such as cleaning products and adhesives, but is no longer used in these products. There is a possibility that using of one of these older household products containing 1,2-dichloroethane to clean floors or glue carpets could result in exposure, since children often crawl on floors and play on carpets. Such exposures would probably last a few days or less, since 1,2-dichloroethane evaporates very quickly. Children are not likely to be exposed to 1,2-dichloroethane from parents' clothing or other items removed from the workplace. Because 1,2-dichloroethane has been detected in human milk, it is possible that young children could be exposed to 1,2-dichloroethane from breast-feeding mothers who had been exposed to sources of 1,2-dichloroethane.

There have been no studies of health effects in children exposed to 1,2-dichloroethane, and we have no reliable information on whether 1,2-dichloroethane causes birth defects in children. One study broadly suggests that heart problems could occur in the human fetus from mothers being exposed to 1,2-dichloroethane along with some other chemicals, but the information is not reliable enough for us to be sure whether 1,2-dichloroethane is responsible for the defects. Studies of pregnant laboratory animals indicate that it probably does not produce birth defects or affect reproduction. We do know, however, that when the pregnant animal is exposed to 1,2-dichloroethane, the fetus is probably also exposed.

It is likely that children exposed to 1,2-dichloroethane after birth would show the same health effects that are expected to occur in adults, especially liver and kidney disease. There is no information to determine whether children differ from adults in their sensitivity to the health effects of 1,2-dichloroethane.

More information regarding children's health and 1,2-dichloroethane can be found in Section 3.7.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO 1,2-DICHLOROETHANE?

If your doctor finds that you have been exposed to significant amounts of 1,2-dichloroethane, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

In the past, 1,2-dichloroethane was used in small amounts in household products such as cleaning agents, pesticides, and wallpaper and carpet glue. It is possible that you may have old containers of such products in your home. Risk of exposure from this source could be eliminated if these older products were immediately discarded. Otherwise, household chemicals should be stored out of reach of young children to prevent accidental poisonings. Always store household chemicals in their original labeled containers. Never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number next to the phone. Sometimes older children sniff household chemicals in an attempt to get high. Your children may be exposed to 1,2-dichloroethane by inhaling products containing it. Talk with your children about the dangers of sniffing chemicals. The exposure of your family to 1,2-dichloroethane can be reduced by throwing away any household products that contain it. You may wish to contact your county health department for appropriate disposal methods.

1,2-Dichloroethane has been found in drinking water in the United States. Most of the time, 1,2-dichloroethane has been found in small amounts that do not pose a major health risk. You may want to contact your water supplier or local health department to get information about the levels of 1,2-dichloroethane in the drinking water.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,2-DICHLOROETHANE?

1,2-Dichloroethane has been found in the breath, blood, breast milk, and urine of exposed people. Because breath samples are easily collected, testing breathed-out or exhaled air is now a possible way to find out whether someone has recently been exposed to 1,2-dichloroethane. However, tests that measure small amounts in human breath, tissues, and fluids may not be available at your doctor's office because they require special equipment. Your physician can refer you to a facility where these tests are done. Although these tests can show that you have been exposed to 1,2-dichloroethane, it is not possible to tell if you will experience any harmful health effects. Because 1,2-dichloroethane leaves the body fairly quickly, these methods are best for finding exposures that occurred within the last several days. Exposure to 1,2-dichloroethane at hazardous waste sites will probably include exposure to other organic compounds at the same time. Therefore, levels of 1,2-dichloroethane measured in the body by these methods may not show exposure to 1,2-dichloroethane only. Medical tests available at a doctor's office include lung-, liver-, and kidney-function tests, but these tests look for damage that has already occurred from general chemical exposure and do not determine the cause of damage. Damage could also be the result of lifestyle (e.g., drinking alcohol, smoking) or general exposure to environmental agents. Other methods to measure the effects of exposure to 1,2-dichloroethane (such as abnormal enzyme levels) do not measure the effects of exposure to 1,2-dichloroethane only, but measure effects of other chemicals as well.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations <u>can</u> be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but <u>cannot</u> be enforced by law. Federal organizations that develop recommendations for toxic substances include the

Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for 1,2-dichloroethane include the following:

The federal government has developed regulatory standards and guidelines to protect people from the possible health effects of 1,2-dichloroethane in air. OSHA has set a limit of 50 parts of 1,2-dichloroethane per million parts of air (ppm, 1 ppm is 1,000 times more than 1 ppb) in the workplace for an 8-hour day, 40-hour week. NIOSH recommends that a person not be exposed daily in the workplace to more than 1 ppm 1,2-dichloroethane for a 10-hour day, 40-hour week. NIOSH calls 1,2-dichloroethane a possible occupational carcinogen. EPA also calls the compound a probable human cancer-causing agent, based on experiments in animals.

The federal government has also set regulatory standards and guidelines to protect people from the possible health effects of 1,2-dichloroethane in drinking water. EPA has set a limit in water of 0.005 milligrams of 1,2-dichloroethane per liter (5 ppb).

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737) or (404) 639-6357
Fax: (404) 639-6359

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological profiles, contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 605-6000

TOXICOLOGICAL PROFILE FOR 1,4-DICHLOROBENZENE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

December 1998

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about 1,4-dichlorobenzene and the effects of exposure.

The Environmental Protection Agency (EPA) has identified 1,467 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. 1,4-Dichlorobenzene has been found in at least 281 NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which 1,4-dichlorobenzene is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it by breathing, eating, touching, or drinking.

If you are exposed to 1,4-dichlorobenzene, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS 1,4-DICHLOROBENZENE?

The chemical 1,4-dichlorobenzene is usually called para-DCB or p-DCB, but there are about 20 additional names for it, including para crystals and paracide. It is also called paramoth because it is one of two chemicals commonly used to make mothballs. 1,4-Dichlorobenzene is used to make deodorant blocks used in garbage cans and restrooms, as well as to help control odors in animal-holding facilities. 1,4-Dichlorobenzene has also been used as an insecticide on fruit and as an agent to control mold and mildew growth on tobacco seeds, leather, and some fabrics.

At room temperature, 1,4-dichlorobenzene is a white solid with a strong odor that you would probably recognize as the smell of mothballs. When a package of 1,4-dichlorobenzene is opened, it slowly changes from a solid into a vapor and is released into the atmosphere. The released vapor acts as a deodorizer and insect killer. Most of the 1,4-dichlorobenzene that is released to the general environment is present as a vapor. 1,4-Dichlorobenzene can burn, but does not burn easily. Most people begin to smell 1,4-dichlorobenzene when it is present in the air at a concentration of 0.18 parts per million (ppm) and in water at a concentration of 0.011 ppm.

1,4-Dichlorobenzene does not occur naturally, but is produced by chemical companies to make products for home use and other chemicals such as resins. More information on the properties and uses of 1,4-dichlorobenzene may be found in Chapters 3 and 4.

1.2 WHAT HAPPENS TO 1,4-DICHLOROBENZENE WHEN IT ENTERS THE ENVIRONMENT?

Most of the 1,4-dichlorobenzene enters the environment as a result of its uses in moth-repellant products and in toilet-deodorizer blocks. Because it changes from a solid to a gas easily, almost all of what is produced is released into the air. Some 1,4-dichlorobenzene is released to the air by factories that make or use it, and minor amounts are released to soil and water. Very little 1,4-dichlorobenzene enters the environment from hazardous waste sites.

Because 1,4-dichlorobenzene does not dissolve easily in water, the small amounts that enter bodies of water quickly evaporate into the air. If it is released to groundwater, it may be transported to surface water. Depending on conditions, some 1,4-dichlorobenzene may bind to soil and sediment. 1,4-Dichlorobenzene in soil is not usually easily broken down by soil organisms. There is evidence that plants and fish absorb 1,4-dichlorobenzene. It has been detected at concentrations up to 400 ppb in fish.

More information on the fate of 1,4-dichlorobenzene in the environment may be found in Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO 1,4-DICHLOROBENZENE?

Humans are exposed to 1,4-dichlorobenzene mainly by breathing vapors from 1,4-dichlorobenzene products used in the home, such as mothballs and toilet-deodorizer blocks. Reported levels of 1,4-dichlorobenzene in some homes and public restrooms have ranged from 0.29 to 272 parts of 1,4-dichlorobenzene per billion parts (ppb) of air. Outdoor levels of 1,4-dichlorobenzene are much lower, and reported levels in cities range from 0.02 to 20 ppb. Even levels in the air around hazardous waste sites are low; reported levels range from 0.03 to 4.25 ppb.

1,4-Dichlorobenzene has also been found in 13% of the drinking water samples from U.S. surface water sources. The surface water samples measured contain about 0.008-154 ppb of 1,4-dichlorobenzene. 1,4-Dichlorobenzene is less likely to be found in drinking water from wells. Levels of 1,4-dichlorobenzene in soil measured around hazardous waste sites in the United States average about 450 ppb. However, background levels of 1,4-dichlorobenzene in soil that is not around waste sites are not known.

1,4-Dichlorobenzene has also been detected in foods such as beef, pork, chicken, and eggs. This is because 1,4-dichlorobenzene is sometimes used as an odor-control product around animal stalls. 1,4-Dichlorobenzene has been found in fish; levels of 1-4 ppb were measured in trout caught in the Great Lakes.

The average daily adult intake of this chemical is estimated to be about 35 micrograms (μg), which comes mainly from breathing vapors of 1,4-dichlorobenzene that are released from products in the home. These levels are not expected to result in harmful effects.

Workers may be exposed to 1,4-dichlorobenzene in workplace air at much higher levels than those to which the general public is exposed. Levels measured in the air of factories that make or process 1,4-dichlorobenzene products have ranged from 5.6 to 748 ppm of air. About 35,000 people in the United States are exposed to very low concentrations of 1,4-dichlorobenzene in the workplace.

More information on how you might be exposed to 1,4-dichlorobenzene is given in Chapter 5.

1.4 HOW CAN 1,4-DICHLOROBENZENE ENTER AND LEAVE MY BODY?

The main way 1,4-dichlorobenzene enters your body is through the lungs when you breathe in 1,4-dichlorobenzene vapors released in the workplace or from home use of products that contain 1,4-dichlorobenzene. When you breathe in this chemical for a few hours, as much as 20% of the 1,4-dichlorobenzene that has entered your body will get into your bloodstream.

1,4-Dichlorobenzene can also get into your body if you drink water that contains this chemical or if you eat certain foods that contain 1,4-dichlorobenzene, such as meat, chicken, eggs, or fish. Most of the 1,4-dichlorobenzene that enters your body from food and water will get into your bloodstream. It is not known if 1,4-dichlorobenzene can enter your body through the skin if you touch products that contain it.

There is also a possibility that 1,4-dichlorobenzene used in the home can be accidentally swallowed, especially by young children. When 1,4-dichlorobenzene is used in mothballs or deodorant blocks, these products may be freely available in closets or bathrooms.

Of the 1,4-dichlorobenzene that enters your body, most of it (perhaps more than 95%) leaves through the urine in less than a week. Another l-2% leaves in the feces, and about l-2% leaves in the air that you breathe out. Tiny amounts remain in your fat and may stay there for a long time.

In your body, most 1,4-dichlorobenzene is changed to the chemical 2,5-dichlorophenol. It is not known if this breakdown product is more or less harmful than 1,4-dichlorobenzene itself.

More information on how 1,4-dichlorobenzene enters and leaves the body is found in Chapter 2.

1.5 HOW CAN 1,4-DICHLOROBENZENE AFFECT MY HEALTH?

Inhaling the vapor or dusts of 1,4-dichlorobenzene at very high concentrations (much higher than you would be exposed to in the home) can be very irritating to your lungs. It may also cause burning and tearing of the eyes, coughing, difficult breathing, and an upset stomach. There is no evidence that the moderate use of common household products that contain 1,4-dichlorobenzene will result in any problems to your health. There are some medical reports of patients who have developed some health effects, such as dizziness, headaches, and liver problems as a result of very high levels of 1,4-dichlorobenzene in the home. However, these were reports of extremely high usage of 1,4-dichlorobenzene products, and the persons continued to use the products for months or even years, even though they felt ill. There are also cases of people who have eaten 1,4-dichlorobenzene products regularly for long periods (months to years) because of its sweet taste. This has caused skin blotches and problems with red blood cells, such as anemia. There is no direct evidence that 1,4-dichlorobenzene causes cancer in humans. Workers breathing high levels of 1,4-dichlorobenzene (80-1 60 ppm) have reported painful irritation of the nose and eyes. There is very little information on the effects of skin contact with 1,4-dichlorobenzene. 1,4-Dichlorobenzene can cause a burning feeling in your skin if you hold a block of 1,4-dichlorobenzene against your skin for a long time.

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

In laboratory animals, breathing or eating 1,4-dichlorobenzene can cause harmful effects in the liver, kidneys, and blood. Rats and mice given oral doses of 1,4-dichlorobenzene in lifetime studies had increased rates of liver cancer when compared with animals that did not receive 1,4-dichlorobenzene.

We do not definitely know if 1,4-dichlorobenzene plays a role in the development of cancer. The Department of Health and Human Services (DHHS) has determined that 1,4-dichlorobenzene may reasonably be anticipated to be a carcinogen in humans. The International Agency for Research on Cancer (IARC) has determined that 1,4-dichlorobenzene is possibly carcinogenic to humans. The EPA has determined that 1,4-dichlorobenzene is a possible human carcinogen.

There is no reliable evidence that suggests that 1,4-dichlorobenzene affects reproduction in humans. More information on how 1,4-dichlorobenzene can affect your health is given in Chapter 2.

1.6 HOW CAN 1,4-DICHLOROBENZENE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

Children are exposed to 1,4-dichlorobenzene in many of the same ways that adults are. There is a possibility that 1,4-dichlorobenzene used in the home can be accidentally swallowed, especially by young children. When 1,4-dichlorobenzene is used in mothballs or toilet bowl deodorant blocks, these products may be freely available in closets or bathrooms. Although most of the exposure pathways for children are the same as those for adults, children may be at a higher risk of exposure because of their lack of consistent hygiene practices and their curiosity about unknown powders and liquids.

Children who are exposed to 1,4-dichlorobenzene would probably exhibit the same effects as adults, although there is very little information on how children react to 1,4-dichlorobenzene exposure. Thus, all health effects observed in adults are of potential concern in children.

There are no studies in humans or animals showing that 1,4-dichlorobenzene crosses the placenta or can be found in fetal tissues. Based on other chemicals like 1,4-dichlorobenzene, it is possible that it could cross the placenta and be found in fetal tissues. There is no credible evidence that suggests that 1,4-dichlorobenzene causes birth defects. One study found dichlorobenzenes in breast milk, but 1,4-dichlorobenzene has not been specifically measured.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO 1,4-DICHLOROBENZENE?

If your doctor finds that you have been exposed to significant amounts of 1,4-dichlorobenzene, ask your doctor if children may also be exposed. When necessary your doctor may need to ask your state Department of Public Health to investigate.

You and your children can be exposed to 1,4-dichlorobenzene in your home if you use products such as 1,4-dichlorobenzene-treated toilet bowl cleaners or mothballs containing 1,4-dichlorobenzene. You should not let your child play with or drink toilet bowl water that has been treated with 1,4-dichlorobenzene. Do not let your children rub mothballs or cleaners containing 1,4-dichlorobenzene on their skin. Because 1,4-dichlorobenzene may be found in the home as a pesticide and bathroom deodorizer and in mothballs, these items should be stored out of reach of young children to prevent accidental poisonings. Always store household chemicals in their original labeled containers; never store household chemicals in containers children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number by the phone.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,4-DICHLOROBENZENE?

There are tests that can be used to find out if you have been exposed to 1,4-dichlorobenzene. The most commonly used test measures its breakdown product, 2,5-dichlorophenol, in urine and blood. These tests require special equipment that is not routinely available in a doctor's office, but they can be performed in a special laboratory.

The presence of the compound 2,5-dichlorophenol in the urine indicates that the person has been exposed to 1,4-dichlorobenzene within the previous day or two. This test has been used in industrial settings in surveys of workers exposed to 1,4-dichlorobenzene. Another test measures levels of 1,4-dichlorobenzene in your blood, but it is less commonly used. Neither of these tests can be used to find out how high the level of 1,4-dichlorobenzene exposure was or to predict whether harmful health effects will follow.

More information on how 1,4-dichlorobenzene can be measured in exposed humans is presented in Chapters 2 and 6.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals, then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for 1,4-dichlorobenzene include the following:

The federal government has taken a number of steps to protect people from excessive 1,4-dichlorobenzene exposure. EPA has listed 1,4-dichlorobenzene as a hazardous waste and has subjected it to hazardous waste regulations. EPA has set a maximum level of 75 μg of 1,4-dichlorobenzene per liter of drinking water. In addition, 1,4-dichlorobenzene is a pesticide registered with EPA, and its manufacturers must provide certain kinds of information to EPA in order for it to be registered for use as a pesticide. OSHA has set a maximum level of 75 ppm for 1,4-dichlorobenzene in workplace air for an 8-hour day, 40-hour work week.

More information on federal and state regulations regarding 1,4-dichlorobenzene is presented in Chapter 7:

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

TOXICOLOGICAL PROFILE FOR ACETONE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

May 1994

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about acetone and the effects of exposure. This information is important because this chemical may harm you.

The Environmental Protection Agency (EPA) has identified 1,350 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are targeted for long-term federal clean-up. Acetone has been found in at least 560 NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance.

As EPA tests more sites, the sites with acetone may increase. This is important because exposure to acetone may harm you and because these sites are or may be sources of exposure.

When a large industrial plant or a small container releases a substance, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it by breathing, eating, touching, or drinking.

If you are exposed to acetone, many factors determine if you'll be harmed and how badly. These factors include the dose (how much), the duration (how long), and how you're exposed. You must also consider the other chemicals you're exposed to and your age, sex, nutritional status, family traits, lifestyle, and state of health.

1.1 WHAT IS ACETONE?

Acetone is a chemical that is found naturally in the environment and is also produced by industries. Low levels of acetone are normally present in the body from the breakdown of fat; the body can use it in normal processes that make sugar and fat (see Section 1.4). Acetone is a colorless liquid with a distinct smell and taste. People begin to smell acetone in air at 100 to 140 parts of acetone in a million parts of air (ppm), though some can smell it at much lower levels. Most people begin to detect the presence of acetone in water at 20 ppm. Acetone evaporates readily into the air and mixes well with water. Most acetone produced is used to make other chemicals that make plastics, fibers, and drugs. Acetone is also used to dissolve other substances. You will find further information on the physical and chemical properties of acetone, and its production and use in Chapters 3 and 4.

1.2 WHAT HAPPENS TO ACETONE WHEN IT ENTERS THE ENVIRONMENT?

Acetone enters the air, water, and soil as a result of natural processes and human activities. Acetone occurs naturally in plants, trees, volcanic gases, and forest fires. People and animals breathe out acetone produced from the natural breakdown of body fat. Acetone is also released during its manufacture and use, in exhaust from automobiles, and from tobacco smoke, landfills, and certain kinds of burning waste materials. The levels of acetone in soil increase mainly because of acetone-containing wastes being buried in landfills. Acetone is present as a gas in air. Some acetone in air is lost when it reacts with sunlight and other chemicals. Rain and snow also remove small amounts of acetone from the atmosphere and, in the process, deposit it on land and water. About half the acetone in a typical atmosphere at any time will be lost in 22 days. Microbes (minute life forms) in water remove some acetone from water. Some acetone in water will evaporate into air. About half the acetone in a stream will be removed from water in less than a day. Fish do not store acetone from water in their bodies. Microbes in soil remove part of the acetone in soil. Some is lost from soil by evaporation. Acetone molecules do not bind tightly to soil. Rainwater and melted snow dissolve acetone and carry it deeper into the soil to groundwater. You will find further information about the fate and movement of acetone in the environment in Chapter 5.

1.3 HOW MIGHT I BE EXPOSED TO ACETONE?

Your body makes small amounts of acetone. You can be exposed to a small amount of acetone by breathing air, drinking water, and eating food with acetone. You can also be exposed by contact with household chemicals with acetone. Several consumer products, including certain nail polish removers, particle board, some paint removers, many liquid or paste waxes or polishes, and certain detergents or cleansers, contain acetone. You can also be exposed to acetone if you are exposed to isopropyl alcohol, because isopropyl alcohol changes to acetone in the body. The level of acetone in air and water is generally low. The amount of acetone in the air of cities is generally higher than in remote and rural areas. The typical level of acetone in the air of cities in the United States is about 7 parts of acetone per billion parts of air (ppb). The level of acetone in air inside homes is usually slightly higher than in outside air (8 ppb versus 7 ppb). This is because of household chemical use inside homes. Acetone in drinking water is so low that its levels have not been measured in many samples. In a national survey, the acetone level in drinking water from Seattle, Washington, was 1 ppb. Acetone occurs naturally in many fruits and vegetables. The amount of acetone in food does not increase because of processing or packaging. The average amount of acetone an adult in the United States gets from food is not known.

People who work in certain industries that process and use acetone can be exposed to higher levels than the general populace. These industries include certain paint, plastic, artificial fiber, and shoe factories. Professional painters and commercial and household cleaners are also likely to breathe or touch higher acetone concentrations than the general population. As a member of the general public, you may be exposed to higher than normal levels of acetone if you smoke cigarettes, frequently use acetone nail polish removers, live near landfill sites that contain acetone, live near busy roadways (because automobile exhaust contains acetone), or live near other facilities that are known to release acetone, such as incinerators. The exposure from these sources will be mainly from breathing air that contains acetone or by direct skin contact with it. In addition, children can be exposed to acetone by eating dirt or by placing dirty hands in their mouths after exposing their skin to dirt from landfill sites. You will find further information about acetone exposure in Chapter 5.

1.4 HOW CAN ACETONE ENTER AND LEAVE MY BODY?

Your body normally contains some acetone because it's made during the breakdown of fat. Your body will make more acetone from body fat if you are on a low-fat diet. In addition to the acetone that your body makes from normal processes, acetone can enter your body if you breathe air that contains acetone, drink water or eat food that contains acetone, or if you touch liquid acetone or soil that contains acetone.

The bloodstream absorbs acetone rapidly and completely from the lungs and stomach. The bloodstream can also absorb acetone from the skin, but less rapidly than from the lungs and stomach. Blood carries acetone to all body organs, but it does not stay there very long.

The liver breaks down acetone to chemicals that are not harmful. The body uses these chemical to make glucose (sugar) and fats that make energy for normal body functions. The breakdown of sugar for energy makes carbon dioxide that leaves your body in the air you breathe out. These are normal processes in the body.

Not all the acetone that enters your body from outside sources is broken down. The amount that is not broken down leaves your body mostly in the air that you breathe out. You also breathe out more carbon dioxide than normal if you are exposed to acetone from sources outside the body because more carbon dioxide is made from the extra acetone.

Only a small amount of acetone that is not broken down leaves the body in the urine. The acetone that is not used to make sugar leaves your body within a few days in the air you breathe out and in the urine. The amount of acetone that enters and leaves your body depends on how much you're exposed to and for how long. The higher the level of acetone and the longer that you are exposed will cause acetone to leave your body more slowly, but almost all the acetone will leave your body within 3 days after your exposure stops. If you exercise or work while exposed to acetone in air, more will enter your lungs because you breathe faster and more deeply during exercise. For more information on how acetone enters and leaves the body, see Chapter 2.

1.5 HOW CAN ACETONE AFFECT MY HEALTH?

As mentioned in Section 1.4, low levels of acetone are normally present in the body from the breakdown of fat. The body uses acetone in normal processes that make sugar and fats that make energy for normal body functions. Many conditions can lead to higher-than-average amounts of acetone in the body. For example, babies, pregnant women, diabetics, and people who exercise, diet, have physical trauma, or drink alcohol can have higher amounts of acetone in their bodies. These higher amounts of acetone usually don't cause health problems. In addition, acetone can prevent convulsions.

Most of the information on how acetone affects human health comes from medical exams of workers on a single workday; from lab experiments in humans exposed to acetone in air for a few days; and from cases of people who swallowed acetone-based glue or fingernail polish remover.

Workers and people exposed to acetone in the lab complained that acetone irritated their noses, throats, lungs, and eyes. Some people feel this irritation at levels of 100 ppm acetone in the air, and more people feel the irritation as the level in air increases. The workers who complained of irritation were exposed to levels of 900 ppm or more. Workers exposed to acetone at 12,000 ppm or higher also complained of headache, lightheadedness, dizziness, unsteadiness, and confusion depending on how long they were exposed (from 2 minutes to 4 hours). Two workers exposed for 4 hours became unconscious.

In addition, some people who had casts applied with acetone were exposed to acetone that evaporated into air during and after the casts were applied. These patients became nauseous, vomited blood, and became unconscious. These cases happened many years ago; modern hospitals have different methods that don't use acetone when casts are applied. Some people exposed to acetone in the air at about 250 ppm for several hours in the lab had headaches and lacked energy, and they also had some mild behavioral effects. These effects showed up in tests of how long it takes to react to a visual stimulus or the ability to hear different sounds. Some people exposed to 500 ppm in the air for several hours in the lab had effects on the blood, but other studies showed no effects on the blood at even higher exposure levels.

Some women exposed to 1,000 ppm for about 8 hours in a lab said that their periods came earlier than expected. Workers are not usually exposed to levels higher than 750 ppm anymore because of current government regulations. The regulation says workroom air should contain no more than an average of 750 ppm. Most people can smell acetone in the air at 100 to 140 ppm; that means you will probably smell acetone before you feel effects like headache and confusion. Levels of acetone in air in rural areas and in cities (less than 8 ppb) are generally lower than this.

People who swallowed acetone or substances that contained acetone became unconscious, but they recovered in the hospital. The amount of acetone that these people swallowed was not always known, but one man swallowed about 2,250 milligrams of pure acetone per kilogram of body weight (2,250 mg/kg). In addition to becoming unconscious, he had tissue damage in his mouth and he later developed a limp, which eventually cleared up, and symptoms similar to diabetes (excessive thirst, frequent urination). The amount of acetone in water or food would never be high enough to cause these effects, but people, especially children, could accidentally swallow enough acetone in nail polish remover or some household cleaners to cause such effects.

In a lab experiment, people who had liquid acetone applied directly on their skin and held there for a half hour developed skin irritation. When the skin was looked at under a microscope, some of the skin cells were damaged.

Animals briefly exposed to high levels of acetone in the air also had lung irritation and became unconscious; some died. Exposure at lower levels for short periods also affected their behavior. Pregnant animals that were exposed to high levels of acetone in air had livers that weighed more than usual and had fewer fetuses. The fetuses weighed less than normal and had delayed bone development. We do not know how exposure to acetone in air for longer than 2 weeks affects animals.

Animals given large amounts of acetone to swallow or drink for short periods had bone marrow hypoplasia (fewer new cells being made), degeneration of kidneys, heavier than normal livers and bigger liver cells, and collapse and listlessness. Pregnant mice that swallowed acetone had lower body weights and produced fewer newborn mice. More of the newborns of mice that had swallowed acetone died than newborns of mice that were not given acetone.

Male rats that swallowed or drank even small amounts of acetone for long periods had anemia and kidney disease. The female rats did not have anemia, but they had kidney disease when they swallowed a much larger amount of acetone than the male rats swallowed. The female rats had livers and kidneys that weighed more than normal, and so did the male rats, but only when they swallowed larger amounts of acetone than the females swallowed. The male rats also had abnormal sperm. The female rats did not have any effects in their reproductive organs. Rats also had signs that acetone caused effects on their nervous systems.

Acetone is irritating to the skin of animals when it is placed directly on their skin, and it burns their eyes when placed directly in their eyes. One kind of animal (guinea pigs) even developed cataracts in their eyes when acetone was placed on their skin.

We do not know whether many of the effects seen in animals would occur in humans. People exposed to acetone were not examined for some effects or could not be examined for effects that can be seen only by looking at internal organs under a microscope. The findings in animals show that male rats are more likely than female rats to get blood and kidney disease and effects on reproductive organs after exposure to acetone. This suggests that men might be more likely to have effects of exposure to acetone than women.

One effect of acetone seen in animals is an increase in the amount of certain enzymes (chemicals in the body that help break down natural substances in the body and chemicals that enter the body). The increase in these enzymes caused by acetone exposure can make some chemicals more harmful. This is one reason that people should be concerned about being exposed to acetone; exposure is very likely to mixtures of chemicals in the environment, near hazardous waste sites, or in the workplace is very likely.

Acetone does not cause skin cancer in animals when it is applied to their skin. We don't know whether acetone would cause cancer after breathing or swallowing it for long periods, because no tests have been done. The Department of Health and Human Services and the International Agency for Research on Cancer have not classified acetone for carcinogenic effects. The EPA has determined that acetone is not classifiable as to its human carcinogenicity.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ACETONE?

Acetone can be measured in the air you breathe out, in the blood, and in the urine. Methods for measuring acetone in breath, blood, and urine are available at most modern testing labs. Doctors' offices may not have the necessary equipment, but your doctor can take blood and urine samples and send them to a testing lab. The measurement of acetone in breath, blood, and urine can determine whether you have been exposed to acetone if the levels are higher than those normally seen. They can even predict how much acetone you were exposed to. However, normal levels of acetone in breath, blood, and urine can vary widely depending on many factors, such as infancy, pregnancy, lactation, diabetes, physical exercise, dieting, physical trauma, and alcohol. The odor of acetone on your breath can alert a doctor that you have been exposed to acetone. An odor of acetone on your breath could also mean that you have diabetes. Because acetone leaves your body within a few days after exposure, these tests can tell only that you have been exposed to acetone within the last 2 or 3 days. These tests cannot tell whether you will experience any health effects related to your exposure.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

EPA requires that spills of 5,000 pounds or more of acetone be reported. To protect workers, the Occupational Safety and Health Administration (OSHA) has set a legal limit of 750 ppm of acetone in workroom air. The regulation means that the workroom air should contain no more than an average of 750 ppm of acetone over an 8-hour working shift or over a 40-hour workweek.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
404-639-6000

This agency can also tell you the location of occupational and environmental health clinics. These clinics specialize in the recognition evaluation, and treatment of illness resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR BENZENE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 1997

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about benzene and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup. Benzene has been found in at least 816 of the 1,428 current or former NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with benzene may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to benzene, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS BENZENE?

Benzene, also known as benzol, is a colorless liquid with a sweet odor. Benzene evaporates into air very quickly and dissolves slightly in water. Benzene is highly flammable. Most people can begin to smell benzene in air at 1.5-4.7 parts of benzene per million parts of air (ppm) and smell benzene in water at 2 ppm. Most people can begin to taste benzene in water at 0.5-4.5 ppm. Benzene is found in air, water, and soil.

Benzene found in the environment is from both human activities and natural processes. Benzene was first discovered and isolated from coal tar in the 1800s. Today, benzene is made mostly from petroleum sources. Because of its wide use, benzene ranks in the top 20 in production volume for chemicals produced in the United States. Various industries use benzene to make other chemicals, such as styrene (for Styrofoam ® and other plastics), cumene (for various resins), and cyclohexane (for nylon and synthetic fibers). Benzene is also used for the manufacturing of some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene, which include volcanoes and forest fires, also contribute to the presence of benzene in the environment. Benzene is also a part of crude oil and gasoline and cigarette smoke. For more information on the nature and uses of benzene, see Chapters 3 and 4.

1.2 WHAT HAPPENS TO BENZENE WHEN IT ENTERS THE ENVIRONMENT?

Benzene is commonly found in the environment. Industrial processes are the main sources of benzene in the environment. Benzene levels in the air can increase from emissions from burning coal and oil, benzene waste and storage operations, motor vehicle exhaust, and evaporation from gasoline service stations. Since tobacco smoke contains high levels of benzene, tobacco smoke is another source of benzene in air. Industrial discharge, disposal of products containing benzene, and gasoline leaks from underground storage tanks can release benzene into water and soil.

Benzene can pass into air from water and soil surfaces. Once in the air, benzene reacts with other chemicals and breaks down within a few days. Benzene in the air can attach to rain or snow and be carried back down to the ground.

Benzene in water and soil breaks down more slowly. Benzene is slightly soluble in water and can pass through the soil into underground water. Benzene in the environment does not build up in plants or animals. For more information on what happens to benzene after it gets into the environment, see Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO BENZENE?

Most people are exposed to a small amount of benzene on a daily basis. You can be exposed to benzene in the outdoor environment, in the workplace, and in the home. Exposure of the general population to benzene is mainly through breathing air that contains benzene. The major sources of benzene exposure are tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions. Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents can also be a source of exposure. Auto exhaust and industrial emissions account for about 20% of the total nationwide exposure to benzene. About 50% of the entire nationwide exposure to benzene results from smoking tobacco or from exposure to tobacco smoke. The average smoker (32 cigarettes per day) takes in about 1.8 milligrams (mg) of benzene per day. This is about 10 times the average daily intake of nonsmokers.

Background levels of benzene in air range from 2.8 to 20 parts of benzene per billion parts of air (ppb) (1 ppb is 1,000 times less than 1 ppm and equals about 3 micrograms of benzene in a cubic meter of air [$\mu g/m^3$]). People living in cities or industrial areas are generally exposed to higher levels of benzene in air than those living in rural areas. Benzene levels in the home are usually higher than outdoor levels. People living around hazardous waste sites, petroleum refining operations, petrochemical manufacturing sites, or gas stations may be exposed to higher levels of benzene in air.

For most people, the level of exposure to benzene through food, beverages, or drinking water is not as high as through air. Typical drinking water contains less than 0.1 ppb benzene. Benzene has been detected in some bottled water, liquor, and food. Leakage from underground gasoline storage tanks or from landfills and hazardous waste sites containing benzene can result in benzene contamination of well water. People with benzene-contaminated tap water can be exposed from drinking the water or eating foods prepared with the water. In addition, exposure can result from breathing in benzene while showering, bathing, or cooking with contaminated water.

Individuals employed in industries that make or use benzene may be exposed to the highest levels of benzene. As many as 238,000 people may be occupationally exposed to benzene in the United States. These industries include benzene production (petrochemicals, petroleum refining, and coke and coal chemical manufacturing), rubber tire manufacturing, and storage or transport of benzene and petroleum products containing benzene. Other workers who may be exposed to benzene because of their occupations include steel workers, printers, rubber workers, shoe makers, laboratory technicians, firefighters, and gas station employees. For more information on how you might be exposed to benzene, see Chapter 5.

1.4 HOW CAN BENZENE ENTER AND LEAVE MY BODY?

Benzene can enter your body through your lungs when you breathe contaminated air. It can also enter through your stomach and intestines when your eat food or drink water that contains benzene. Benzene can enter your body through skin contact with benzene-containing products such as gasoline.

When you are exposed to high levels of benzene in air, about half of the benzene you breathe in leaves your body when you breathe out. The other half passes through the lining of your lungs and enters your bloodstream. Animal studies show that benzene taken in by eating or drinking contaminated foods behaves similarly in the body to benzene that enters through the lungs. A small amount will enter your body by passing through your skin and into your bloodstream during skin contact with benzene or benzene-containing products. Once in the bloodstream, benzene travels throughout your body and can be temporarily stored in the bone marrow and fat. Benzene is converted to products, called metabolites, in the liver and bone marrow. Some of the harmful effects of benzene exposure are believed to be caused by these metabolites. Most of the metabolites of benzene leave the body in the urine within 48 hours after exposure. For more information on how benzene can enter and leave your body, see Chapter 2.

1.5 HOW CAN BENZENE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

After exposure to benzene, several factors determine whether harmful health effects will occur and if they do, what the type and severity of these health effects might be. These factors include the amount of benzene to which you are exposed and the length of time of the exposure. Most data involving effects of long-term exposure to benzene are from studies of workers employed in industries that make or use benzene. These workers were exposed to levels of benzene in air far greater than the levels normally encountered by the general population. Current levels of benzene in workplace air are much lower than in the past. Because of this reduction, and the availability of protective equipment such as respirators, fewer workers have symptoms of benzene poisoning.

Brief exposure (5-10 minutes) to very high levels of benzene in air (l0,000-20,000 ppm) can result in death. Lower levels (700-3,000 ppm) can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. In most cases, people-will stop feeling these effects when they stop being exposed and begin to breathe fresh air.

Eating foods or drinking liquids containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, coma, and death. The health effects that may result from eating foods or drinking liquids containing lower levels of benzene are not known. If you spill benzene on your skin, it may cause redness and sores. Benzene in your eyes may cause general irritation and damage to your cornea.

Benzene causes problems in the blood. People who breathe benzene for long periods may experience harmful effects in the tissues that form blood cells, especially the bone marrow. These effects can disrupt normal blood production and cause a decrease in important blood components. A decrease in red blood cells can lead to anemia. Reduction in other components in the blood can cause excessive bleeding. Blood production may return to normal after exposure to benzene stops. Excessive exposure to benzene can be harmful to the immune system, increasing the chance for infection and perhaps lowering the body's defense against cancer.

Benzene can cause cancer of the blood-forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Cancer Research (IARC) has determined that benzene is carcinogenic to humans, and the EPA has determined that benzene is a human carcinogen. Long-term exposure to relatively high levels of benzene in the air can cause cancer of the blood-forming organs. This condition is called leukemia. Exposure to benzene has been associated with development of a particular type of leukemia called acute myeloid leukemia (AML).

Exposure to benzene may be harmful to the reproductive organs. Some women workers who breathed high levels of benzene for many months had irregular menstrual periods. When examined, these women showed a decrease in the size of their ovaries. However, exact exposure levels were unknown, and the studies of these women did not prove that benzene caused these effects. It is not known what effects exposure to benzene might have on the developing fetus in pregnant women or on fertility in men. Studies with pregnant animals show that breathing benzene has harmful effects on the developing fetus. These effects include low birth weight, delayed bone formation, and bone marrow damage.

The health effects that might occur in humans following long-term exposure to food and water contaminated with benzene are not known. In animals, exposure to food or water contaminated with benzene can damage the blood and the immune system and can even cause cancer. See Chapter 2 for more information on the health effects resulting from benzene exposure.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO BENZENE?

Several tests can show if you have been exposed to benzene. Some of these tests may be available at your doctor's office. All of these tests are limited in what they can tell you. The test for measuring benzene in your breath must be done shortly after exposure. This test is not very helpful for detecting very low levels of benzene in your body. Benzene can be measured in your blood. However, since benzene disappears rapidly from the blood, measurements may be accurate only for recent exposures. In the body, benzene is converted to products called metabolites. Certain metabolites of benzene, such as phenol, muconic acid, and S-phenyl-N-acetyl cysteine (PhAC) can be measured in the urine. The amount of phenol in urine has been used to check for benzene exposure in workers. The test is useful only when you are exposed to benzene in air at levels of 10 ppm or greater. However, this test must also be done shortly after exposure, and it is not a reliable indicator of how much benzene you have been exposed to, since phenol is present in the urine from other sources (diet, environment). Measurement of muconic acid or PhAC in the urine is a more sensitive and reliable indicator of benzene exposure. The measurement of benzene in blood or of metabolites in urine cannot be used for making predictions about whether you will experience any harmful health effects. Measurement of all parts of the blood and measurement of bone marrow are used to find benzene exposure and its health effects.

For people exposed to relatively high levels of benzene, complete blood analyses can be used to monitor possible changes related to exposure. However, blood analyses are not useful when exposure levels are low. For more information on tests for benzene exposure, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals, then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for benzene include the following:

EPA has set the maximum permissible level of benzene in drinking water at 5 parts per billion (ppb). Because benzene can cause leukemia, EPA has set a goal of 0 ppb for benzene in drinking water and in water such as rivers and lakes. EPA estimates that 10 ppb benzene in drinking water that is consumed regularly or exposure to 0.4 ppb benzene in air over a lifetime could cause a risk of one additional cancer case for every 100,000 exposed persons. EPA recommends a maximum permissible level of benzene in water of 200 ppb for shortterm exposures (10 days) for children.

EPA requires that the National Response Center be notified following a discharge or spill into the environment of 10 pounds or more of benzene.

The Occupational Safety and Health Administration (OSHA) regulates levels of benzene in the workplace. The maximum allowable amount of benzene in workroom air during an 8-hour workday, 40-hour workweek is 1 part per million (ppm). Since benzene can cause cancer, the National Institute for Occupational Safety and Health (NIOSH) recommends that all workers likely to be exposed to benzene wear special breathing equipment (NIOSH 1974). For more information on federal regulations, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mails top E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: (404) 639-6000
Fax: (404) 639-6315 or 6324

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR BROMODICHLOROMETHANE

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

In collaboration with:

U.S. Environmental Protection Agency (EPA)

December 1989

1. PUBLIC HEALTH STATEMENT

1.1 WHAT IS BROMODICHLOROMETHANE?

Bromodichloromethane (BDCM) is a colorless, heavy, nonburnable liquid. BDCM does not usually exist as a liquid in the environment. Rather, it usually is found evaporated in air or dissolved in water.

Most BDCM in the environment is formed as a by-product when chlorine is added to drinking water to kill disease-causing organisms. Small amounts of BDCM are also made in chemical plants for use in laboratories or in making other chemicals. A very small amount (less than 1% of the amount coming from human activities) is formed by algae in the ocean.

BDCM evaporates quite easily, so most BDCM that escapes into the environment from chemical facilities, waste sites, or drinking water enters the atmosphere as a gas. BDCM is slowly broken down (about 90% in a year) by chemical reactions in the air. Any BDCM that remains in water or soil may also be broken down slowly by bacteria.

Further information on the properties and uses of BDCM, and how it behaves in the environment, may be found in Chapters 3, 4, and 5.

1.2 HOW MIGHT I BE EXPOSED TO BROMODICHLOROMETHANE?

For most people, the most likely means of exposure to BDCM is by drinking chlorinated water. Usually the levels in drinking water are between 1 and 10 ppb (parts per billion). BDCM is also found in some foods and beverages such as ice cream or soft-drinks that are made using chlorinated water, but this is probably not a major source of exposure. BDCM has been found in chlorinated swimming pools, where exposure might occur by breathing the vapors or through the skin. Exposure to BDCM might also occur by breathing BDCM in the air in or near a laboratory or factory that made or used BDCM. However, BDCM is not widely used in this country, so this is not likely for most people. Average levels of BDCM in air are usually quite low (less than 0.2 ppb). Another place where human exposure might occur is near a waste site where BDCM has been allowed to leak into water or soil. In this situation, people could be exposed by drinking the water or by getting the soil on their skin. BDCM has been found in water and soil at some waste sites (about 1% to 10% of those tested), usually at levels of 1 to 50 ppb. Further information on how people might be exposed to BDCM is given in Chapter 5.

1.3 HOW CAN BROMODICHLOROMETHANE ENTER AND LEAVE MY BODY?

Studies in animals show that almost all BDCM swallowed in water or food will enter the body by moving from the stomach or intestines into the blood. It is likely that BDCM would also move from the lungs into the blood if it were breathed in and would cross the skin if skin contact occurred, but this has not been studied. Bromodichloromethane leaves the body mostly by being breathed out through the lungs. Smaller amounts leave in the urine and feces. BDCM removal is fairly rapid and complete (about 95% in 8 hours), so it does not usually build up in the body. Further information on how BDCM enters and leaves the body is given in Chapter 2.

1.4 HOW CAN BROMODICHLOROMETHANE AFFECT MY HEALTH?

The effects of BDCM depend on how much is taken into the body. In animals, the main effect of eating or drinking large amounts of BDCM is injury to the liver and kidneys, These effects can occur within a short time after exposure. High levels can also cause effects on the brain, leading to incoordination and sleepiness. There is some evidence that BDCM can be toxic to developing fetuses, but this has not been well-studied. Studies in animals show that intake of BDCM for several years in food or water can lead to cancer of the liver, kidney and intestines. Although effects of BDCM have not been reported in humans, effects would probably occur if enough BDCM were taken into the body. Further information on how BDCM can affect the health of humans and animals is presented in Chapter 2.

1.5 IS THERE A MEDICAL TEST TO DETERMINE IF I HAVE BEEN EXPOSED TO BROMODICHLOROMETHANE?

Methods are available to measure low levels of BDCM in human blood, breath, urine and fat, but not enough information is available to use such tests to predict if any health effects might result. Because special equipment is needed, these tests are not usually done in doctors' offices. Because BDCM leaves the body fairly quickly, these methods are best suited to detecting recent exposures. Further information on how BDCM can be measured in exposed humans is presented in Chapter 6.

1.6 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Tables 1-1 through 1-4 show the relationship between exposure to BDCM and known health effects. Minimal Risk Levels (MRLs) are also included in Table 1-3. These MRLs were derived from animal data for both short-term and longer-term exposure, as described in Chapter 2 and in Table 2-1. These MRLs provide a basis for comparison with levels that people might encounter either in food or drinking water. If a person is exposed to BDCM at an amount below the MRL, it is not expected that harmful noncancer health effects will occur. Because these levels are based only on information currently available, some uncertainty is always associated with them. Also, because the method for deriving MRLs does not use any information about cancer, a MRL does not imply anything about the presence, absence or level of risk of cancer. Further information on the levels of BDCM that have been observed to cause health effects in animals is presented in Chapter 2.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The U.S. Environmental Protection Agency (EPA) has set a Maximum Contaminant Level in drinking water of 0.10 ppm (parts per million) for the combination of BDCM and a group of similar compounds (trihalomethanes). Most water samples in the U.S. have BDCM levels lower than this. The Food and Drug Administration (FDA) has set the same limit for bottled water, but no tolerance limits have been set for BDCM in food. Because it has such limited use in industry, there is no Occupational Safety and Health Administration standard for BDCM. Further information on regulations concerning BDCM is presented in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have further questions or concerns, please contact your State Health or Environmental Department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

TABLE 1-1. Human Health Effects from Breathing BDCM*

Short-term Exposure (less than or equal to 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from short-term human exposure to air containing specific levels of BDCM are not known.
Long-term Exposure (greater than 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects
		The health effects resulting from long-term human exposure to air containing specific levels of BDCM are not known.

* See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-2. Animal Health Effects from Breathing BDCM

Levels in Air (ppm)	Length of Exposure	Description of Effects
Short-term Exposure (less than or equal to 14 days)		
		The health effects resulting from short-term animal exposure to air containing specific levels of BDCM are not known.
Long-term Exposure (greater than 14 days)		
		The health effects resulting from long-term animal exposure to air containing specific levels of BDCM are not known.

TABLE 1-3. Human Health Effects from Eating or Drinking BDCM*

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
1.3		Estimated Minimal Risk Level (based on studies in animals; see Section 1.6 for discussion)
Levels in Water (ppm)		
		The health effects resulting from short-term human exposure to water containing specific levels of BDCM are not known.
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
0.6		Estimated Minimal Risk Level (based on studies in animals; see Section 1.6 for discussion)
Levels in Water (ppm)		
		The health effects resulting from long-term human exposure to water containing specific levels of BDCM are not known.

* See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-4. Animal Health Effects from Eating or Drinking BDCM

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
280	14 days	Liver injury in mice.
570	14 days	Kidney injury in mice.
1,000	10 days	Impaired fetal development in rats.
1,200	14 days	Death in mice.
Levels in Water (ppm)		
		The health effects resulting from short-term animal exposure to water containing specific levels of BDCM are not known.
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
190	2 years	Kidney injury in mice.
380	2 years	Liver injury in mice.
Levels in Water (ppm)		
		The health effects resulting from long-term animal exposure to water containing specific levels of BDCM are not known.

* These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

TOXICOLOGICAL PROFILE FOR CARBON TETRACHLORIDE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

May 1994

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about carbon tetrachloride and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,350 hazardous waste sites as the most serious in the nation. These sites comprise the "National Priorities List" (NPL): Those sites which are targeted for long-term federal cleanup activities. Carbon tetrachloride has been found in at least 314 of the sites on the NPL. However, the number of NPL sites evaluated for carbon tetrachloride is not known. As EPA evaluates more sites, the number of sites at which carbon tetrachloride is found may increase. This information is important because exposure to carbon tetrachloride may cause harmful health effects and because these sites are potential or actual sources of human exposure to carbon tetrachloride.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to a substance such as carbon tetrachloride, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, gender, nutritional status, family traits, life-style, and state of health.

1.1 WHAT IS CARBON TETRACHLORIDE?

Carbon tetrachloride is a clear liquid that evaporates very easily. Most carbon tetrachloride that escapes to the environment is therefore found as a gas. Carbon tetrachloride does not easily burn. Carbon tetrachloride has a sweet odor, and most people can begin to smell it in air when the concentration reaches 10 parts carbon tetrachloride per million parts of air (ppm). It is not known whether people can taste it or, if they can, at what level.

Carbon tetrachloride does not occur naturally but has been produced in large quantities to make refrigeration fluid and propellants for aerosol cans. Since many refrigerants and aerosol propellants have been found to affect the earth's ozone layer, the production of these chemicals is being phased out. Consequently, the manufacture and use of carbon tetrachloride will probably decline a great deal in the future.

In the past, carbon tetrachloride was widely used as a cleaning fluid (in industry and dry cleaning establishments as a degreasing agent, and in households as a spot remover for clothing, furniture, and carpeting. Carbon tetrachloride was also used in fire extinguishers and as a fumigant to kill insects in grain. Most of these uses were discontinued in the mid-1960s. Until recently, carbon tetrachloride was used as a pesticide, but this was stopped in 1986.

Further information on the properties and uses of carbon tetrachloride can be found in Chapters 3, 4, and 5.

1.2 WHAT HAPPENS TO CARBON TETRACHLORIDE WHEN IT ENTERS THE ENVIRONMENT?

Because carbon tetrachloride evaporates easily, most of the compound released to the environment during its production and use reaches the air, where it is found mainly as a gas. It can remain in air for several years before it is broken down to other chemicals. Small amounts of carbon tetrachloride are found in surface water. Because it evaporates easily, much of it will move from surface water in to the air within a few days or weeks. However, it may be trapped in groundwater for longer periods. Carbon tetrachloride is not expected to stick to soil particles. If spilled onto the ground, much of it will evaporate to the air. Some of it may also go in to groundwater, where it can remain for months before it is broken down to other chemicals. It is not expected to build up in fish. We do not know if it builds up in plants.

Further information on what happens to carbon tetrachloride in the environment may be found in Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO CARBON TETRACHLORIDE?

Very low background levels of carbon tetrachloride are found in air, water, and soil because of past and present releases. Concentrations in air of 0.1 part carbon tetrachloride per billion parts of air (ppb) are common around the world, with somewhat higher levels often found (0.2-0.6 ppb) in cities. Carbon tetrachloride is also found in some drinking water supplies, usually at concentrations less than 0.5 ppb. Exposure to levels of carbon tetrachloride higher than these typical "background" levels is likely to occur only at specific industrial locations where carbon tetrachloride is still used or near chemical waste sites where emissions into air, water, or soil are not properly controlled. Exposure at such sites could occur by breathing carbon tetrachloride present in the air, by drinking water contaminated with carbon tetrachloride, or by getting soil contaminated with carbon tetrachloride on the skin. Young children may also be exposed if they eat soil that contains carbon tetrachloride. Carbon tetrachloride has been found in water or soil at about 22% of the waste sites investigated under Superfund, at concentrations ranging from less than 50 to over 1,000 ppb.

People who work with carbon tetrachloride are likely to receive the greatest exposure to the compound. The National Institute for Occupational Safety and Health (NIOSH) estimates that 58,208 workers are potentially exposed to carbon tetrachloride in the United States. The average daily intake of carbon tetrachloride for the general population is estimated to be 0.1 microgram (μg). The estimated average daily amount that the general population may drink in water is 0.01 μg.

Further information on the ways that humans can be exposed to carbon tetrachloride is presented in Chapter 5.

1.4 HOW CAN CARBON TETRACHLORIDE ENTER AND LEAVE MY BODY?

Carbon tetrachloride can enter your body through your lungs if you breathe air containing carbon tetrachloride, or through your stomach and intestines if you swallow food or water containing carbon tetrachloride. Carbon tetrachloride can also pass through the skin into the body. When you inhale carbon tetrachloride, over 30-40% of what you inhale enters your body, where most of it temporarily accumulates in body fat. Some can enter the kidney, liver, brain, lungs, and skeletal muscle. When you drink water contaminated with carbon tetrachloride about 85-91% of it can enter your body. Much of the compound that enters your body when you breathe it or drink water contaminated with it leaves your body quickly, and a lot of it can be found in your breath within a few hours. Animal studies indicated that under differing conditions, 34-75 % of carbon tetrachloride is excreted in expired air, 20-62% is excreted in feces, and only low amounts are excreted in the urine. Animal studies also suggest that it may take weeks for the remainder of the compound in the body to be eliminated, especially that which has entered the body fat. Most of the carbon tetrachloride is eliminated from your body unchanged, but some may change to other chemicals (for example, chloroform, hexachloroethane, and carbon dioxide). Chloroform and hexachloroethane may themselves cause harmful effects.

Further information on how carbon tetrachloride enters and leaves the body is presented in Chapter 2.

1.5 HOW CAN CARBON TETRACHLORIDE AFFECT MY HEALTH?

Most information on the health effects of carbon tetrachloride in humans comes from cases where people have been exposed to relatively high levels of carbon tetrachloride, either only once or for a short period of time. Experiments have not been performed on the effects of long-term exposure of humans to low levels of carbon tetrachloride, so the human health effects of such exposures are not known.

The liver is especially sensitive to carbon tetrachloride. In mild cases, the liver becomes swollen and tender, and fat builds up inside the organ, In severe cases, liver cells may be damaged or destroyed, leading to a decrease in liver function. Such effects are usually reversible if exposure is not too high or too long.

The kidney is also sensitive to carbon tetrachloride. Less urine may be formed, leading to a buildup of water in the body (especially in the lungs) and buildup of waste products in the blood. Kidney failure often was the main cause of death in people who died after very high exposure to carbon tetrachloride.

Fortunately, if injuries to the liver and kidney are not too severe, these effects disappear after exposure stops. This is because both organs can repair damaged cells and replace dead cells and associated materials. Function usually returns to normal within a few days or weeks after exposure.

After exposure to high levels of carbon tetrachloride, the nervous system, including the brain, is affected. Such exposure can be fatal. The immediate effects are usually signs of intoxication, including headache, dizziness, and sleepiness perhaps accompanied by nausea and vomiting. These effects usually disappear within a day or two after exposure stops. In severe cases, stupor or even coma can result, and permanent damage to nerve cells can occur.

Carbon tetrachloride also causes effects on other tissues of the body, but these are not usually as common or important as the effects on the liver, kidney, and brain. Limited human studies suggest that drinking water exposure to carbon tetrachloride might possibly be related to certain birth defects, low birthweight, and small size at birth. Information from animal studies indicates that carbon tetrachloride does not cause birth defects, but might decrease the survival rate of newborn animals.

Studies in animals have shown that carbon tetrachloride given by mouth can increase the frequency of liver tumors in some species. Studies have not been performed to determine if breathing carbon tetrachloride causes tumors in animals, or whether swallowing or breathing carbon tetrachloride causes tumors in humans, but it should be assumed that carbon tetrachloride could produce cancer. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen (i.e., cause cancer). The International Agency for Research on Cancer (IARC) has determined that carbon tetrachloride is possibly carcinogenic to humans. The EPA has determined that carbon tetrachloride is a probable human carcinogen.

Many reported cases of carbon tetrachloride toxicity are associated with drinking alcohol. The frequent drinking of alcoholic beverages increases the danger from carbon tetrachloride exposure.

Further information on the health effects of carbon tetrachloride may be found in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CARBON TETRACHLORIDE?

Several very sensitive and specific tests can detect carbon tetrachloride in exposed persons. The most convenient way is simply to measure carbon tetrachloride in exhaled air, but carbon tetrachloride can also be measured in blood, fat, or other tissues. Because special equipment is needed, these tests are not routinely performed in doctors' offices; but your doctor can refer you to where you can obtain such a test. Although these tests can show that a person has been exposed to carbon tetrachloride, the test results cannot be used to reliably predict whether any bad health effects might result. Because carbon tetrachloride leaves the body fairly quickly, these methods are best suited to detecting exposures that have occurred measured in exposed humans is given in Chapter 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

To protect citizens from exposure to carbon tetrachloride, the federal government has limited or banned the use of this compound in most common household products and fire extinguishers, and has discontinued its use as a pesticide. To protect workers who use carbon tetrachloride while on the job, the Occupational Safety and Health Administration (OSHA) has set a maximum concentration limit in workplace air of 2 ppm for an 8-hour workday over a 40-hour work week. EPA has also set limits on how much carbon tetrachloride can be released from an industrial plant into waste water and is preparing to set limits on how much carbon tetrachloride can escape from a plant into outside air. To ensure that drinking water supplies are safe, EPA has set a Maximum Contaminant Level (MCL) for carbon tetrachloride of 5 parts per billion (ppb), based on analytical detection limits in drinking water. Because carbon tetrachloride is possibly carcinogenic to humans, a Maximum Contaminant Level Goal (MCLG) of zero has been proposed. More detailed information on federal and state regulations regarding carbon tetrachloride may be found in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
(404) 639-6000

TOXICOLOGICAL PROFILE FOR CHLOROBENZENE

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

December 1990

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about chlorobenzene and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,177 sites on its National Priorities List (NPL). Chlorobenzene has been found at 97 of these sites. However, we do not know how many of the 1,177 NPL sites have been evaluated for chlorobenzene. As EPA evaluates more sites, the number of sites at which chlorobenzene is found may change. The information is important for you because chlorobenzene may cause harmful health effects and because these sites are potential or actual sources of human exposure to chlorobenzene.

When a chemical is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous substance such as chlorobenzene, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

1.1 WHAT IS CHLOROBENZENE?

Chlorobenzene is a colorless liquid with an almond-like odor. The compound does not occur widely in nature, but is manufactured for use as a solvent (a substance used to dissolve other substances) and is used in the production of other chemicals. Chlorobenzene persists in soil (several months), in air (3.5 days), and water (less than 1 day). Additional information can be found in Chapters 3, 4, and 5.

1.2 HOW MIGHT I BE EXPOSED TO CHLOROBENZENE?

There is potential for humans to be exposed to chlorobenzene by breathing contaminated air, by drinking water or eating food contaminated with chlorobenzene, or by getting chlorobenzene-contaminated soil on the skin. These exposures are most likely to occur in the workplace or in the vicinity of chemical waste sites.

Occupational exposure occurs primarily through breathing the chemical. Personnel engaged in the production and handling of chlorobenzene would be at greatest risk. Levels of chlorobenzene in the air at several industrial sites during normal operations were found to be below allowable federal standards.

Exposure in humans could occur in persons living or working in the vicinity of hazardous waste sites if emissions to water, air, and soil are not adequately controlled. Chlorobenzene has been found at 97 out of 1,177 NPL hazardous waste sites in the United States. Thus, federal and state surveys suggest that chlorobenzene is not a widespread environmental contaminant. The chemical has not been detected in surface water, although a few ground water systems have been found with chlorobenzene levels in the parts per billion (ppb) range. Background levels of less than 1 ppb were detected in air samples from urban and suburban areas. No information of the occurrence of chlorobenzene in food has been found. Additional information on the potential for human exposure is presented in Chapter 5.

1.3 HOW CAN CHLOROBENZENE ENTER AND LEAVE MY BODY?

Chlorobenzene enters your body when you breathe in air containing it, when you drink water or eat food containing it, or when it comes in contact with your skin. Human exposure to contaminated water could occur near hazardous waste sites where chlorobenzene is present. Significant exposure to chlorobenzene is not expected to occur by getting chlorobenzene contaminated soil on your skin. When chlorobenzene enters your body, most of it is expelled from your lungs in the air we breathe out and in urine. Additional information is presented in Chapter 2.

1.4 HOW CAN CHLOROBENZENE AFFECT MY HEALTH?

Workers exposed to high levels of chlorobenzene complained of headaches, numbness, sleepiness, nausea, and vomiting. However, it is not known if chlorobenzene alone was responsible for these health effects since the workers may have also been exposed to other chemicals at the same time. Mild to severe depression of functions of parts of the nervous system is a common response to exposure to a wide variety of industrial solvents (a substance that dissolves other substances).

In animals, exposure to high concentrations of chlorobenzene affects the brain, liver, and kidneys. Unconsciousness, tremors and restlessness have been observed. The chemical can cause severe injury to the liver and kidneys. Data indicate that chlorobenzene does not affect reproduction or cause birth defects. Studies in animals have shown that chlorobenzene can produce liver nodules, providing some but not clear evidence of cancer risk. Additional information on health effects is presented in Chapter 2.

1.5 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Harm to human health from breathing, eating or drinking chlorobenzene is not established (Tables 1-1 and 1-3). Tables 1-2 and 1-4 show the relationship between exposure to chlorobenzene and known health effects in animals. A Minimal Risk Level (MRL) is included in Table 1-3. The MRL was derived from animal data for long-term exposure, as described in Chapter 2 and in Table 2-2. The MRL provides a basis for comparison with levels that people might encounter either in the air or in food or drinking water. If a person is exposed to chlorobenzene at an amount below the MRL, it is not expected that harmful (noncancer) health effects will occur. Because this level is based only on information currently available, some uncertainty is always associated with it. Also, because the method for deriving MRLs does not use any information about cancer, a MRL does not imply anything about the presence, absence, or level of risk for cancer. Further information on the levels of chlorobenzene that have been observed to cause health effects in animals is presented in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CHLOROBENZENE?

Exposure to chlorobenzene can be determined by measuring the chemical or its metabolite in urine, exhaled air, blood, and body fat. Tests are not routinely available at the doctor's office. Specific tests are available that can determine if exposure is currently occurring or has occurred very recently, but not whether exposure occurred in the past. Further, levels in the various media stated above do not predict adverse health effects. Additional information on how chlorobenzene can be measured in exposed humans is given in Chapters 2 and 6.

TABLE 1-1. Human Health Effects from Breathing Chlorobenzene*

Short-term Exposure (less than or equal to 14 days)		
Levels in Air	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of humans to air containing specific levels of chlorobenzene are not known.
Long-term Exposure (greater than 14 days)		
Levels in Air	Length of Exposure	Description of Effects
		The health effects resulting from long-term exposure of humans to air containing specific levels of chlorobenzene are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-2. Animal Health Effects from Breathing Chlorobenzene

Short-term Exposure (less than or equal to 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects*
537	2 hours	Death in rabbits.
Long-term Exposure (greater than 14 days)		
Levels in Air (ppm)	Length of Exposure	Description of Effects*
75	24 weeks	Liver and kidney damage in rats and rabbits.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

TABLE 1-3. Human Health Effects from Eating or Drinking Chlorobenzene

Short-term Exposure (less than or equal to 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of humans to food containing specific levels of chlorobenzene are not known.
Levels in Water		
		The health effects resulting from short-term exposure of humans to water containing specific levels of chlorobenzene are not known.

Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects
15	91 days	Minimal Risk Level (based *on animal studies; see* Section 1.5 for discussion).
Levels in Water		
		The health effects resulting from long-term exposure of animals to water containing specific levels of chlorobenzene are not known.

TABLE 1-4. Animal Health Effects from Eating or Drinking Chlorobenzene

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
7,692 - 20,000	1-14 days	Death in mice and rats.
Levels in Water		
		The health effects of short-term exposure of animals to water containing specific levels of chlorobenzene are not known.
Long-term Exposure (greater than 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
1,923 - 5,000	91 days	Liver and kidney damage in mice. Liver injury rats.
1,923	13 weeks	Injury to organs of the immune system in mice.
1,923	13 weeks	Death in mice.
Levels in Water		
		The health effects resulting from long-term exposure of animals to water containing specific levels of chlorobenzene are not known.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The Federal Government has developed regulatory standards and advisories to protect individuals from potential health effects of cholorobenzene in the environment. The Environmental Protection Agency has proposed that the maximum level of chlorobenzene in drinking water be 0.1 parts per million (ppm). For short-term exposures to drinking water, EPA has recommended that drinking water levels not exceed 2 ppm for up to ten days. The Occupational Safety and Health Administration (OSHA) has established a legally enforceable minimum limit of 75 ppm of chlorobenzene in workplace air for an 8 hour/day, 40-hour work week. Additional information regarding federal and state regulations is presented in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns not covered here, please contact your State Health or Environmental Department or:

Agency for Toxic Substance and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

This agency can also give you information on the location of the nearest occupational and environmental health clinics. Such clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR CHLOROETHANE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

December 1998

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about chloroethane and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Chloroethane has been found in at least 282 of the 1,467 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which chloroethane is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to chloroethane, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS CHLOROETHANE?

Chloroethane, also called ethyl chloride, is a colorless gas at room temperature and pressure, with a characteristically sharp odor. People can smell chloroethane in the air at levels above 4 parts chloroethane in a million parts of air by volume (ppm). It can be smelled in water at levels above 0.02 parts chloroethane in a million parts of water (ppm). In pressurized containers, chloroethane exists as a liquid. However, the liquid evaporates quickly when exposed to air. It catches fire easily and is very dangerous when exposed to heat or flame. Chloroethane does not occur naturally in the environment. It is present in the environment as a result of human activity.

In the past, the largest single use for chloroethane was for the production of tetraethyl lead, which is a gasoline additive. However, production of chloroethane has decreased dramatically as a result of stricter government regulations controlling lead in gasoline. Other applications include use in the production of ethyl cellulose, dyes, medicinal drugs, and other commercial chemicals, and use as a solvent and refrigerant. It is used to numb skin prior to medical procedures such as ear piercing and skin biopsies, and it is used in the treatment of sports injuries.

1.2 WHAT HAPPENS TO CHLOROETHANE WHEN IT ENTERS THE ENVIRONMENT?

Most of the chloroethane released to the environment ends up as a gas in the atmosphere, while much smaller amounts enter groundwater as a result of passage through soil. Once in the atmosphere, chloroethane breaks down fairly rapidly by reaction with substances in the air. It takes about 40 days for half of any given amount of chloroethane that is released to the atmosphere to disappear. In groundwater, chloroethane changes slowly to ethanol and a chloride salt as a result of reaction with water. In addition, some types of bacteria present in the water may break down chloroethane to smaller compounds. However, not enough is known about chloroethane to be sure if this occurs or how long it may remain in groundwater. For more information, see Chapters 3,4, and 5.

1.3 HOW MIGHT I BE EXPOSED TO CHLOROETHANE?

Humans can be exposed to chloroethane from environmental, occupational, and consumer sources. During the mid-to-late 1970s and the early 1980s chloroethane was detected in samples of outdoor air. Air samples collected in urban and suburban areas contained chloroethane at an average level of 41-140 parts of chloroethane in a trillion parts of air (ppt; 1 ppt is 1,000,000 times less than 1 ppm). Rural air samples contained less than 5 ppt. Current levels of chloroethane in the air are expected to be even lower than levels found in the past because of the sharp decrease in chloroethane production in the United States and the decrease in chloroethane release. Occurrences of chloroethane in air can be attributed to releases from factories that manufacture or use chloroethane; evaporation from some landfills, solvents, refrigerants, and anesthetics; and releases in fumes from the burning of plastics and other materials found in trash. Based on the limited amount of information available on the occurrence of chloroethane in drinking water, it can be concluded that extremely low levels of chloroethane may occur in some drinking water supplies as a result of formation during chlorination, contamination of rivers and lakes used as drinking water supplies, or seepage into groundwater resulting from storage of chemical wastes or disposal at waste sites. However, there is not enough information available to indicate what levels of chloroethane occur in drinking water under these circumstances. No data were located that indicate that chloroethane is found in food.

Exposure may also result from contact with various consumer products including some solvents, paints, and refrigerants. People may be exposed to chloroethane through skin contact as the result of its use as an agent to numb skin before ear piercing, before skin biopsy, as a treatment for sports injury, and for other medical reasons. Occupational exposure may result from inhalation or skin contact. Workers who may be exposed to chloroethane include physicians, nurses, and other medical workers, automobile mechanics, office machine mechanics, household appliance and accessory installers, assemblers, professional painters, heavy-equipment mechanics, diesel mechanics, plumbers, and pipe fitters. According to a National Institute for Occupational Safety and Health (NIOSH) survey conducted between 1981 and 1983, au estimated 49,212 workers in the United States were exposed to chloroethane in the workplace. More recent data are not available to determine how many workers might be exposed to chloroethane per year in the United States. For further information, see Chapter 5.

1.4 HOW CAN CHLOROETHANE ENTER AND LEAVE MY BODY?

Chloroethane can enter the body when a person breathes air containing chloroethane vapor. Chloroethane may also enter the body through the skin, although most of it quickly evaporates from the skin's surface. When a person drinks water containing chloroethane, it enters the body through the digestive tract. After chloroethane enters the body, it may leave the body through the lungs. Some chloroethane may also be changed to acetate, which is normally found in the body. Other chemicals formed from chloroethane leave the body in the urine.

People who happen to be near hazardous waste sites containing chloroethane are most likely to be exposed to the compound by breathing potentially contaminated air. People may also be exposed to chloroethane by drinking potentially contaminated water. See Chapter 2 for more information.

1.5 HOW CAN CHLOROETHANE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Brief exposure to high levels of chloroethane vapor can produce temporary feelings of drunkenness, and at still higher levels, lack of muscle coordination and unconsciousness. Adults have felt dizzy and have suffered decreased reaction times as a result of inhaling chloroethane. They have also experienced stomach cramps, nausea, vomiting, and eye irritation after breathing high concentrations of chloroethane for a short time.

Workers who breathed chloroethane vapors for 1.5 to 3 years (levels of chloroethane unknown) had significantly decreased defensive responses against illness. Inhalant abusers who intentionally breathe chloroethane vapors at much higher concentrations than those found in any work environment or near any hazardous waste site have experienced these neurological effects. Long term abuse of high chloroethane concentrations causes the most adverse effects of chloroethane exposure, namely, those to the nervous system. In the worst recorded cases of chloroethane abuse by sniffing, the abusers have had severe symptoms including jerking eye movements, an inability to control muscles in voluntary movements, difficulty in speaking clearly, an inability to perform finger tapping exercises, sluggish lower limb reflexes, seizures, difficulties in walking, disorientation, short-term memory loss, and hallucinations affecting their sight and hearing. In one case, damage to motor and sensory nerves occurred.

Human patients have died after breathing chloroethane concentrations high enough to induce anesthesia. Dogs have suffered irregular heart rhythms, followed by death, when given anesthetic doses of chloroethane. Due to the risk of accidental death, chloroethane is no longer medically used as a general anesthetic during major surgery. Chloroethane can, however, be applied to the skin in the form of chloroethane spray as a numbing agent prior to minor surgery. If this spray is applied for too long, frostbite can result. Some adults have had allergic reactions to the chloroethane spray while others experienced mild pain after being sprayed for 10 seconds.

Studies have shown that chloroethane can enhance the effects of alcohol in rats. It is unknown if similar interactions between chloroethane and alcohol occur in humans.

It is not known whether chloroethane produces cancer in humans. However, long-term exposure to high levels of chloroethane vapor has been shown to produce cancer in mice. There have been no animal or human studies involving the ability of chloroethane to cause cancer when either eaten or applied to the skin. The International Agency for Research on Cancer (IARC) has reviewed the information available concerning the ability of chloroethane to cause cancer. They concluded that chloroethane is not classifiable as to its carcinogenicity in humans. See Chapter 2 for more information.

1.6 HOW CAN CHLOROETHANE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans. Potential effects on children resulting from exposures of the parents are also considered.

There are no known unique exposure pathways by which children may be exposed to chloroethane.

In children, there have been few recorded reports of exposures to chloroethane or adverse health effects resulting from this exposure. Brief inhalation exposure of children to very high concentrations of chloroethane has resulted in stimulation of certain nerves followed by a decrease in heart rate. One teenager died from lung paralysis during general anesthesia with chloroethane. In addition to these health effects seen specifically in children, the observed adverse effects of chloroethane exposure in adults are also expected in children. It is unknown whether children differ from adults in their susceptibility to health effects from chloroethane exposure.

We do not know whether chloroethane exposure can affect development in humans. There is not enough information to know whether chloroethane affects development in animals. Only one developmental study has been done in animals. This study with mice showed that exposure to high levels of chloroethane during pregnancy delayed bone development in the offspring.

We do not know whether chloroethane or its breakdown products within the body can reach and cross the mother's placenta into her developing baby. One study has shown that chloroethane can be found in mother's milk, but we do not know if the mothers were exposed to the compound by breathing it, eating it, or having it sprayed on their skin.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO CHLOROETHANE?

If your doctor finds that you have been exposed to significant amounts of chloroethane, ask if children may also be exposed. When necessary your doctor may need to ask your state Department of Public Health to investigate.

Little information exists concerning the concentrations of chloroethane that might be present in drinking water. However, past data indicate that chloroethane is not a frequent contaminant in drinking water, and therefore the risk to families from drinking water containing chloroethane is low.

Chloroethane is found in common household products such as paints, solvents, air fresheners, and deodorant sprays. Inhaling or ingesting toxic amounts of chloroethane from these products is possible. Therefore, household products such as these should be stored out of reach of young children to prevent accidental poisonings. Always store household chemicals in their original labeled containers; never store household chemicals in containers children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number by the phone.

Sometimes older children sniff household chemicals in an attempt to get high. Chloroethane is sold in drug paraphernalia shops as Ethyl Gaz, Ethyl Four Star, Black Jac, and Maximum Impact. Your children may be exposed to chloroethane by inhaling products containing it and are putting their health at serious risk if they do so. Talk with your children about the dangers of sniffing chemicals.

When household products that contain chloroethane are used properly and are not abused, the concentrations of chloroethane within them are not high enough to pose a risk of significant exposure to children.

The tendency of chloroethane to evaporate upon contact with air makes it highly unlikely that the compound could be taken home on the parents' work clothes.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CHLOROETHANE?

Although there are complex analytical tests that chemists use to measure chloroethane in the blood, milk, or urine, there are no commonly used medical tests available to determine whether or not a person has been exposed to chloroethane. A breath test to determine exposure may be possible but is not commonly used.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals, then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for chloroethane include the following:

Chloroethane levels in the workplace are regulated by QSHA. The occupational exposure limit for an g-hour work day of a 40-hour work week is 1,000 ppm. The EPA requires industry to report discharges or spills of 100 pounds or more. See Chapter 7 for more information.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: l-800-447- 1544
Fax: (404) 639-6359

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological nrofnes. contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 487-4650

TOXICOLOGICAL PROFILE FOR CHLOROFORM

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 1997

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about chloroform and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and the sites are targeted for long-term federal cleanup. Chloroform has been found in at least 717 of the 1,430 current or former NPL sites, including 6 in Puerto Rico and 1 in the Virgin Islands. However, it's unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with chloroform may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to chloroform, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS CHLOROFORM?

Chloroform is also known as trichloromethane or methyltrichloride. It is a colorless liquid with a pleasant, nonirritating odor and a slightly sweet taste. Most of the chloroform found in the environment comes from industry. It will only burn when it reaches very high temperatures. Chloroform was one of the first inhaled anesthetics to be used during surgery, but it is not used for anesthesia today. Nearly all the chloroform made in the United States today is used to make other chemicals, but some is sold or traded to other countries. We also import chloroform.

Chloroform enters the environment from chemical companies and paper mills, It is also found in waste water from sewage treatment plants and drinking water to which chlorine has been added. Chlorine is added to most drinking water and many waste waters to destroy bacteria. Small amounts of chloroform are formed as an unwanted product during the process of adding chlorine to water. Chloroform can enter the air directly from factories that make or use it and by evaporating from water and soil that contain it. It can enter water and soil when waste water that contains chlorine is released into water or soil. It may enter water and soil from spills and by leaks from storage and waste sites. There are many ways for chloroform to enter the environment, so small amounts of it are likely to be found almost everywhere. You will find more information about what chloroform is, how it is used, and where it comes from in Chapters 3 and 4.

1.2 WHAT HAPPENS TO CHLOROFORM WHEN IT ENTERS THE ENVIRONMENT?

Chloroform evaporates very quickly when exposed to air. Chloroform also dissolves easily in water, but does not stick to the soil very well. This means that it can travel down through soil to groundwater where it can enter a water supply. Chloroform lasts for a long time in both the air and in groundwater. Most chloroform in the air eventually breaks down, but this process is slow. The breakdown products in air include phosgene, which is more toxic than chloroform, and hydrogen chloride, which is also toxic. Some chloroform may break down in soil. Chloroform does not appear to build up in great amounts in plants and animals, but we may find some small amounts of chloroform in foods. You will find more information about where chloroform comes from, how it behaves, and how long it remains in the environment in Chapter 5.

1. PUBLIC HEALTH STATEMENT

1.3 HOW MIGHT I BE EXPOSED TO CHLOROFORM?

You are probably exposed to small amounts of chloroform in your drinking water and in beverages (such as soft drinks) made using water that contains chloroform. You can also get chloroform in your body by eating food, by breathing air, and by skin contact with water that contains it. You are most likely to be exposed to chloroform by drinking water and breathing indoor or outdoor air containing it. The amount of chloroform normally expected to be in the air ranges from 0.02 to 0.05 parts of chloroform per billion parts (ppb) of air and from 2 to 44 ppb in treated drinking water. However, in some places, chloroform concentrations may be higher than 44 ppb. It is estimated that the concentration of chloroform in surface water is 0.1 ppb, the concentration in untreated groundwater is 0.1 ppb, and the amount in soil is 0.1 ppb. As much as 610 ppb was found in air at a municipal landfill and up to 88 ppb was found in treated municipal drinking water. Drinking water derived from well water near a hazardous waste site contained 1,900 ppb, and groundwater taken near a hazardous waste site also contained 1,900 ppb. Surface water containing 394 ppb has also been found near a hazardous waste site; however, no more than 0.13 ppb has been found in soil at hazardous waste sites. Chloroform has been found in the air from all areas of the United States and in nearly all of the public drinking water supplies. We do not know how many areas have surface water, groundwater, or soil that contains chloroform.

The average amount of chloroform that you might be exposed to on a typical day by breathing air in various places ranges from 2 to 5 micrograms per day μg/day) in rural areas, 6 to 200 μg/day in cities, and 80 to 2,200 μg/day in areas near major sources of the chemical. The estimated amount of chloroform you probably are exposed to in drinking water ranges from 4 to 88 μg/day. We cannot estimate the amounts that you may be exposed to by eating food and by coming into contact with water that has chloroform in it. People who swim in swimming pools absorbed chloroform through their skin. People who work at or near chemical plants and factories that make or use chloroform can be exposed to higher-thannormal amounts of chloroform. Higher exposures might occur in workers at drinking-water treatment plants, waste water treatment plants, and paper and pulp mills. People who operate waste-burning equipment may also be exposed to higher than normal levels. The National

I. PUBLIC HEALTH STATEMENT

Institute for Occupational Safety and Health (NIOSH) estimated that 95,778 persons in the United States have occupational exposure to chloroform. You will find more information about how you can be exposed to chloroform in Chapter 5.

1.4 HOW CAN CHLOROFORM ENTER AND LEAVE MY BODY?

Chloroform can enter your body if you breathe air, eat food, or drink water that contains chloroform. Chloroform easily enters your body through the skin. Therefore, chloroform may also enter your body if you take a bath or shower in water containing chloroform. In addition, you can breathe in chloroform if the shower water is hot enough for chloroform to evaporate. Studies in people and in animals show that after you breathe air or eat food that has chloroform in it, the chloroform can quickly enter your bloodstream from your lungs or intestines. Inside your body, chloroform is carried by the blood to all parts of your body, such as the fat, liver, and kidneys. Chloroform usually collects in body fat; however, its volatility ensures that it will eventually be removed once the exposure has been removed. Some of the chloroform that enters your body leaves unchanged in the air that you breathe out, and some chloroform in your body is broken down into other chemicals. These chemicals are known as breakdown products or metabolites, and some of them can attach to other chemicals inside the cells of your body and may cause ha.rmful effects if they collect in high enough amounts in your body. Some of the metabolites also leave the body in the air you breathe out. Only a small amount of the breakdown products leaves the body in the urine and stool.

You can find more information about the behavior of chloroform in the body in Chapter 2.

1.5 HOW CAN CHLOROFORM AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

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One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

In humans, chloroform affects the central nervous system (brain), liver, and kidneys after a person breathes air or drinks liquids that contain large amounts of chloroform. Chloroform was used as an anesthetic during surgery for many years before its harmful effects on the liver and kidneys were recognized. Breathing about 900 parts of chloroform in a million parts of air (900 ppm or 900,000 ppb) for a short time causes fatigue, dizziness, and headache. If you breathe air, eat food, or drink water containing elevated levels of chloroform, over a long period, the chloroform may damage your liver and kidneys. Large amounts of chloroform can cause sores when the chloroform touches your skin.

We do not know whether chloroform causes harmful reproductive effects or birth defects in people. Miscarriages occurred in rats and mice that breathed air containing elevated levels (30 to 300 ppm) of chloroform during pregnancy and in rats that ate chloroform during pregnancy. Abnormal sperm were found in mice that breathed air containing elevated levels (400 ppm) of chloroform for a few days. Offspring of rats and mice that breathed chloroform during pregnancy had birth defects.

Results of studies of people who drank chlorinated water showed a possible link between the chloroform in chlorinated water and the occurrence of cancer of the colon and urinary bladder. Cancer of the liver and kidneys developed in rats and mice that ate food or drank water that had large amounts of chloroform in it for a long time. We do not know whether liver and kidney cancer would develop in people after long-term exposure to chloroform in drinking water. Based on animal studies, the Department of Health and Human Services (DHHS) has determined that chloroform may reasonably be anticipated to be a carcinogen (a substance that causes cancer). The International Agency for Research on Cancer (IARC) has determined that chloroform is possibly carcinogenic to humans (2B). The EPA has determined that chloroform is a probable human carcinogen.

You can find a more complete discussion about how chloroform affects your health in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CHLOROFORM?

Although we can measure the amount of chloroform in the air that you breathe out, and in blood, urine, and body tissues, we have no reliable test to determine how much chloroform you have been exposed to or whether you will experience any harmful health effects. The measurement of chloroform in body fluids and tissues may help to determine if you have come into contact with large amounts of chloroform. However, these tests are useful only a short time after you are exposed to chloroform because it leaves the body quickly. Because it is a breakdown product of other chemicals (chlorinated hydrocarbons), chloroform in your body might also indicate that you have come into contact with those other chemicals. Therefore, small amounts of chloroform in the body may indicate exposure to these other chemicals and may not indicate low chloroform levels in the environment. From blood tests to determine the amount of liver enzymes, we can tell whether the liver has been damaged, but we cannot tell whether the liver damage was caused by chloroform.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop

1. PUBLIC HEALTH STATEMENT

recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for chloroform include the following:

The EPA sets rules for the amount of chloroform allowed in water. The EPA limit for total trihalomethanes, a class of chemicals that includes chloroform, in drinking water is 100 micrograms per liter (μg/L, 1 μg/L = 1 ppb in water). Furthermore, EPA requires that spills of 10 pounds or more of chloroform into the environment be reported to the National Response Center.

OSHA sets the levels of chloroform allowed in workplace air in the United States. A permissible occupational exposure limit is 50 ppm or 240 mg/m^3 (ceiling value) in air during an 8-hour workday, 40-hour workweek.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance
Phone: (404) 639-6000
Fax: (404) 639-6315 or 6324

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological profiles, contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 487-4650

TOXICOLOGICAL PROFILE FOR
METHYL tert-BUTYL ETHER

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

August 1996

air in cities or near highways. MTBE is used to treat gallstones, so patients treated with this medical procedure will have some exposure.

1.4 HOW CAN MTBE ENTER AND LEAVE MY BODY?

MTBE can enter your body rapidly if you breathe air, drink water, or eat food that contains it. If your skin comes into contact with MTBE, it can enter your body through the skin, but this happens more slowly. Most of the MTBE that you breathe in or take in by mouth can get into your blood. Not as much gets into the blood through the skin. No matter how you are exposed, a large amount of MTBE is breathed out without being changed into other chemicals. The MTBE that is not breathed out is changed into other chemicals such as butyl alcohol, methyl alcohol, formaldehyde, formic acid, and carbon dioxide. These chemicals also leave the body quickly in the air that you breathe out or in the urine. MTBE does not stay in any organs of your body for a long time. Most of it and its breakdown products leave the body in 1 or 2 days. For more information, see Chapter 2.

1.5 HOW CAN MTBE AFFECT MY HEALTH?

Some people who were exposed to MTBE while pumping gasoline, driving their cars, or working as attendants or mechanics at gas stations complained of headaches, nausea, dizziness, irritation of the nose or throat, and feelings of spaciness or confusion. These symptoms were reported when high levels of MTBE were added to gasoline in order to lower the amount of carbon monoxide, a known poison, released from cars. MTBE has a very unpleasant odor that most people can smell before any harmful effects would occur, but some people might feel irritation of the nose or throat before noticing the smell. MTBE caused side effects in some patients who were given MTBE to dissolve gallstones. The MTBE is given to these patients through special tubes that are placed into their gallbladders. If MTBE leaks from the gallbladder into other areas of the body, the patient can have minor liver damage, a lowering of the amount of white blood cells, nausea, vomiting, sleepiness, dizziness, and confusion. These effects are not long lasting.

1. PUBLIC HEALTH STATEMENT

We know more about how MTBE affects the health of animals than the health of humans. Some rats and mice died after they breathed high amounts of MTBE, but these levels were much higher than people are likely to be exposed to. MTBE also caused irritation to the noses and throats of animals that breathed MTBE, The most common effect of MTBE in animals is on their nervous systems. Breathing MTBE at high levels can cause animals to act as if they are drunk. For example, some became less active, staggered, fell down, were unable to get up, and had partially closed eyelids. These effects lasted only for about an hour, and then the animals seemed normal again. Some animals that breathed high levels of MTBE for several hours a day for several weeks gained less weight than normal, probably because they ate less food while they were inactive. When rats breathed high levels of MTBE for several hours every day for two years, some got more serious kidney disease than these rats usually get as they grow old. Some of the male rats developed cancer in the kidney, but whether this has meaning for people is not known When mice breathed high levels of MTBE for several hours every day for a year and a half, some had larger livers than normal, and some mice developed tumors in the liver. When rats were given high levels of MTBE by mouth for 2 years, some male rats developed cancer in the testes and some female rats developed cancer of the blood (leukemia) and cancer (lymphoma) of some of the tissues that produce blood cells. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified MTBE for its ability to cause cancer. When pregnant rats, rabbits, or mice breathed MTBE, birth defects occurred only in the baby mice. We do not know if this has any relevance for people. MTBE did not affect the animals' ability to reproduce.

Some rats and mice died after being given very large amounts of MTBE by mouth. The amounts were much higher than people are likely to swallow from drinking water containing MTBE. The effects on the nervous system in animals that are given MTBE by mouth are the same as the effects that occur in animals that breathe MTBE. Some animals that were given MTBE by mouth had diarrhea and irritation in their stomachs and intestines. Some animals also had very slight liver damage.

MTBE irritated the skin of animals when it was placed directly on their skin. MTBE also irritated the eyes of animals when it was placed in their eyes or when air containing MTBE came into contact with their eyes. For more information on the health effects of MTBE, please see Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO MTBE?

There are no specific medical tests to determine whether you have been exposed to MTBE. But MTBE and its breakdown product, butyl alcohol, can be measured in exhaled air, in blood, and in urine. Because MTBE and its breakdown products leave the body in 1 or 2 days, these measurements can only tell if you have been exposed recently. The effects of exposure to MTBE, such as stomach aches, fatigue, and dizziness, are common to many chemicals and illnesses. These symptoms are not very useful in determining whether you were exposed to this particular chemical. For more information, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

To protect workers, the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that the amount in workroom air be limited to 100 parts per million (ppm) in an 8-to 10-hour work shift. At this time, governmental agencies such the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), and EPA have not established exposure criteria for MTBE. For more information, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR METHYLENE CHLORIDE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 2000

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about methylene chloride and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Methylene chloride has been found in at least 882 of the 1,569 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which methylene chloride is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to methylene chloride, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS METHYLENE CHLORIDE?

Methylene chloride, also known as dichloromethane, is a colorless liquid that has a mild sweet odor, evaporates easily, and does not burn easily. It is widely used as an industrial solvent and as a paint stripper. It can be found in certain aerosol and pesticide products and is used in the manufacture of photographic film. The chemical may be found in some spray paints, automotive cleaners, and other household products. Methylene chloride does not appear to occur naturally in the environment. It is made from methane gas or wood alcohol. Most of the methylene chloride released to the environment results from its use as an end product by various industries and the use of aerosol products and paint removers in the home.

More information on the properties and uses of methylene chloride may be found in Chapters 3 and 4.

1.2 WHAT HAPPENS TO METHYLENE CHLORIDE WHEN IT ENTERS THE ENVIRONMENT?

Methylene chloride is mainly released to the environment in air, and to a lesser extent in water and soil, due to industrial and consumer uses. Many chemical waste sites, including NPL sites, contain methylene chloride and these might act as additional sources of environmental contamination through spills, leaks, or evaporation. Because methylene chloride evaporates readily, most of it is released into the air. In the air, it is broken down by sunlight and by reaction with other chemicals present in the air. About half of the methylene chloride disappears from air in 53 to 127 days. Although methylene chloride does not dissolve easily in water, small amounts may be found in some drinking water. Methylene chloride that is present in water is broken down slowly by reactions with other chemicals or by bacteria. Over 90% of the methylene chloride in the environment changes to carbon dioxide (CO_2), which is already present in air. It takes about 1 to 6 days for half the methylene chloride to break down in water. When methylene chloride is spilled on land, it attaches loosely to nearby surface soil particles. It moves from the soil into the air. Some may also move into groundwater. We do not know how long it remains in soil. We do not expect methylene chloride to build up in plants or animals.

More information on what happens to methylene chloride in the environment may be found in Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO METHYLENE CHLORIDE?

You may be exposed to methylene chloride in air, water, food, or from consumer products. Because methylene chloride evaporates easily, the greatest potential for exposure is when you breathe vapors of contaminated air. Background levels in air are usually at less than one part methylene chloride per billion parts (ppb) of air. Methylene chloride has been found in some urban air and at some hazardous waste sites at average concentrations of 11 ppb of air. The average daily intake of methylene chloride from outdoor air in three U.S. cities ranges from 33 to 309 micrograms per day (1 milligram is equivalent to 1,000 micrograms, 1 mg = 1,000 μg.) Contact with consumer products such as paint strippers or aerosol cans that contain methylene chloride is another frequent source of exposure. Exposure occurs as a result of breathing the vapors given off by the product or from direct contact of the liquid material with the skin. The highest and most frequent exposures to methylene chloride usually occur in workplaces where the chemical is used; exposure can be dangerously high if methylene chloride is used in an enclosed space without adequate ventilation. People who work with it can breathe in the chemical or it may come in contact with their skin. In the past, concentrations ranging from 1 to 1,000 parts of methylene chloride per million parts of air (ppm; 1 ppm is 1,000 times more than 1 ppb) have been detected in general work areas, while higher concentrations (1,400 ppm) have been detected in samples in the breathing zone of some workers. These exposure levels exceed the current recommended federal limits. The National Institute for Occupational Safety and Health (NIOSH) estimated that 1 million workers may be exposed to methylene chloride. Averages of 68 ppb of methylene chloride in surface water and 98 ppb methylene chloride in groundwater have been found at some hazardous waste sites. Less than 1 ppb has been found in most drinking water analyzed. We expect exposure from water and food to be low because very little methylene chloride has been detected in these sources.

More information on how you might be exposed to methylene chloride is given in Chapter 5.

1.4 HOW CAN METHYLENE CHLORIDE ENTER AND LEAVE MY BODY?

Methylene chloride may enter your body when you breathe vapors of contaminated air. It may also enter your body if you drink water from contaminated wells, or it may enter if your skin comes in contact with it. Since methylene chloride evaporates into air rapidly, exposure by breathing is the most likely source of exposure at hazardous waste sites, in the home, and in the workplace. When you breathe in methylene chloride, over 70% of it enters your bloodstream and quickly spreads throughout your body, with most of it going to the liver, kidney, brain, lungs, and fatty tissue. Increased physical activity or an increased amount of body fat tends to increase the amount of methylene chloride that remains or accumulates in your body tissue. About half of the methylene chloride in the blood leaves within 40 minutes. Some of the methylene chloride is broken down into other chemicals, including carbon monoxide (CO), a natural substance in the body occurring from the breakdown of hemoglobin. Unchanged methylene chloride and its breakdown products are removed from your body mainly in the air you breathe out. Small amounts leave in your urine. This usually occurs within 48 hours after exposure. Although the rate of uptake through the stomach has not been measured, uptake is likely to be fast. Skin absorption is usually small. Trapping the chemical against the skin with clothing or gloves can lead to greater absorption and possible chemical burns.

More information on how methylene chloride enters and leaves the body is given in Chapter 2.

1.5 HOW CAN METHYLENE CHLORIDE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

If you breathe large amounts (800 ppm) of methylene chloride you may not be able to react fast, remain steady, or perform tasks requiring precise hand movements. You may experience dizziness, nausea, tingling or numbness of the fingers and toes, and drunkenness if you breathe methylene chloride for a sufficiently long period of time. In most cases, effects disappear shortly after the exposure ends. Studies in animals suggest that exposure to higher concentrations (8,000–20,000 ppm) can lead to unconsciousness and death. There have been reports of some people becoming unconscious and some people dying after breathing high concentrations of methylene chloride; accidents of this kind happen more often when methylene chloride is used without adequate ventilation.

Breathing methylene chloride may cause changes in the liver and kidney in animals, but similar effects have not been observed in humans. Animal studies indicate that should you be exposed to high levels of vapors of methylene chloride in air, the vapors may irritate your eyes and affect your cornea. One study reported these effects at concentrations of 490 ppm; however, the effects usually disappeared within a few days.

In humans, direct skin contact with large amounts of methylene chloride causes intense burning and mild redness of the skin. In a workplace accident in which a person was found to have lost consciousness and partly fallen into an open vat of methylene chloride, extended direct contact with the liquid caused severe burns of the skin and eyes (cornea); these conditions were treatable. In rabbits, effects were observed on the eyes (e.g., cornea), but they were reversible within a few days.

People can smell methylene chloride at about 200 ppm in air. After about 3 hours of exposure at this level, a person will become less attentive and less accurate in tasks that require hand-eye coordination. Because people differ in their ability to smell various chemicals, odors may not be helpful in avoiding over-exposure to methylene chloride.

There is not clear evidence that methylene chloride causes cancer in humans exposed to vapors in the workplace. However, breathing high concentrations of methylene chloride for long periods of time did increase the incidence of cancer in mice. No information was found regarding the cancer-causing effects of methylene chloride in humans after oral exposure. The Department of Health and Human Services (DHHS) has determined that methylene chloride may reasonably be anticipated to be a cancer-causing chemical. The International Agency for Research on Cancer (IARC) has classified methylene chloride in Group 2B, possibly causing cancer in humans. The EPA has determined that methylene chloride is a probable cancer-causing agent in humans.

More information on how methylene chloride can affect your health is given in Chapter 2.

1.6 HOW CAN METHYLENE CHLORIDE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children and adults may be exposed to low levels of methylene chloride in drinking water. Small children who live near factories that produce or use methylene chloride could accidently eat some of the chemical by putting dirty hands in their mouths, but the amount of methylene chloride in the soil is thought to be too low to be harmful. Children could breathe in methylene chloride that is used in a number of household products, since it evaporates easily. Also, since the vapor of methylene chloride is heavier than air, it will tend to stay close to the ground; as a result, children, being shorter, would breathe in larger amounts than adults during accidental exposure.

The effects of methylene chloride have not been studied in children, but they would likely experience the same health effects seen in adults exposed to the chemical. It is also not known if the way in which methylene chloride is absorbed, metabolized, and eliminated from the body is different in children than it is in adults. Therefore, adverse effects noted in animals and adult humans (as discussed in Section 1.5) might also occur in children.

There have not been any reports of a connection between methylene chloride exposure during pregnancy and birth defects in humans. If a pregnant woman is exposed to methylene chloride, a small amount may cross the placenta, but not enough to harm the fetus. Studies in animals show that breathing methylene chloride at relatively high levels during pregnancy may lead to bone variations, none of which are serious and some of which may be outgrown, in newborn pups. Methylene chloride has been shown to cross the placenta in rats. Methylene chloride has not been accurately measured in human milk and there are no animal studies testing to what extent it can pass into milk.

Sections 2.7 and 5.6 contain specific information about the effects of methylene chloride in children.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO METHYLENE CHLORIDE?

If your doctor finds that you have been exposed to significant amounts of methylene chloride, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

Children may be exposed to methylene chloride in consumer household products, such as paint removers, which contain a large percentage of methylene chloride. In general, the amounts of methylene chloride in consumer products are low and children are not likely to be harmed unless large amounts contact the skin or are accidentally swallowed. Using paint removers, especially in unventilated or poorly ventilated areas, may cause the amount of methylene chloride in the air to reach potentially dangerous levels. Caution should be used when using paint removers inside your house; you should follow instructions on the package label for the proper ventilation conditions when using these products. It is also advisable to make certain that children do not remain near indoor paint removal activities.

Household chemicals should be stored out of reach of young children to prevent accidental poisonings or skin irritation. Always store household chemicals in their original labeled containers. Never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number next to the phone.

Sometimes older children sniff household chemicals in an attempt to get high. Your children may be exposed to methylene chloride by inhaling products containing it. Talk with your children about the dangers of sniffing chemicals.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO METHYLENE CHLORIDE?

Several tests exist for determining whether you have had measurable exposure to methylene chloride. The most direct method measures methylene chloride in the air you breathe out. Your blood can also be analyzed to determine if methylene chloride is present. However, these tests are only useful for detecting exposures which have occurred within a few days because methylene chloride remains in the blood for a very short time. Some absorbed methylene chloride is stored in fat and slowly returns to the bloodstream. A test to measure carboxyhemoglobin (COHb), a chemical formed in blood as methylene chloride breaks down in the body, can also be used as an indicator of exposure. However, this test is not specific, since smoking and exposure to other chemicals may also increase COHb levels. Your urine can also be tested for methylene chloride itself or for other chemicals (such as formic acid) that are produced as methylene chloride breaks down in the body. These tests are not routinely available in a doctor's office, and they require special equipment. Also, the test for formic acid is not specific for methylene chloride, since other chemicals, such as formaldehyde, are broken down to formic acid. The tests may be useful to determine exposure to methylene chloride but do not by themselves measure or predict health effects.

More information on how methylene chloride can be measured in exposed humans is presented in Chapters 2 and 6.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for methylene chloride include the following:

The EPA requires that releases of methylene chloride of 1,000 pounds or more be reported to the federal government. The EPA has provided guidelines on how much methylene chloride you may be exposed to for certain amounts of time without causing risk to human health. It recommends that exposure of children to methylene chloride in drinking water should not exceed 10 milligrams/liter (mg/L) for 1 day or 2 mg/L for 10 days.

Because methylene chloride is used in processing spices, hops extract, and decaffeinated coffee, the FDA has established limits on the amounts of methylene chloride that can remain in these food products.

The OSHA currently has a "permissible exposure limit" (PEL) of 25 ppm for an 8-hour workday with 125 ppm as a "short-term exposure limit" (STEL) for 15 minute durations for persons who work with methylene chloride.

NIOSH no longer has a "recommended exposure limit" (REL) for methylene chloride. Because methylene chloride causes tumors in some animals, NIOSH currently considers it a possible cancer-causing substance in the workplace and recommends that exposure be lowered to the lowest feasible limit.

More information on government recommendations regarding methylene chloride can be found in Chapter 7.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737)
Fax: (404) 639-6359

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological profiles, contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 605-6000

TOXICOLOGICAL PROFILE FOR TETRACHLOROETHYLENE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 1997

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about tetrachloroethylene and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup. Tetrachloroethylene has been found in at least 771 of the 1,430 current or former NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with tetrachloroethylene may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact.

If you are exposed to tetrachloroethylene, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS TETRACHLOROETHYLENE?

Tetrachloroethylene is a synthetic chemical that is widely used for dry cleaning of fabrics and for metal-degreasing operations. It is also used as a starting material (building block) for making other chemicals and is used in some consumer products. Other names for tetrachloroethylene include perchloroethylene, PCE, pert, tetrachloroethene, perclene, and perchlor. It is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. Most people can smell tetrachloroethylene when it is present in the air at a level of 1 part in 1 million parts of air (ppm) or more. In an experiment, some people could smell tetrachloroethylene in water at a level of 0.3 ppm. For more information, see Chapters 3 and 4.

1.2 WHAT HAPPENS TO TETRACHLOROETHYLENE WHEN IT ENTERS THE ENVIRONMENT?

Tetrachloroethylene enters the environment mostly by evaporating into the air during use. It can also get into water supplies and the soil during disposal of sewage sludge and factory waste and when leaking from underground storage tanks. Tetrachloroethylene may also get into the air, soil, or water by leaking or evaporating from storage and waste sites. It can stay in the air for several months before it is broken down into other chemicals or is brought back down to the soil and water by rain.

Much of the tetrachloroethylene that gets into water and soil will evaporate into the air. However, because tetrachloroethylene can travel through soils quite easily, it can get into underground drinking water supplies. If it gets into underground water, it may stay there for many months without being broken down. If conditions are right, bacteria will break down some of it and some of the chemicals formed may also be harmful. Under some conditions, tetrachloroethylene may stick to the soil and stay there. It does not seem to build up in animals that live in water, such as fish, clams, and oysters. We do not know if it builds up in plants grown on land. For more information on tetrachloroethylene in the environment, see Chapters 4 and 5.

1.3 HOW MIGHT 1 BE EXPOSED TO TETRACHLOROETHYLENE?

People can be exposed to tetrachloroethylene from environmental and occupational sources and from consumer products. Common environmental levels of tetrachloroethylene (called background levels) are several thousand times lower than levels found in some workplaces. Background levels are found in the air we breathe, in the water we drink, and in the food we

1. PUBLIC HEALTH STATEMENT

eat. The chemical is found most frequently in air and, less often, in water. Tetrachloroethylene gets into air by evaporation from industrial or dry cleaning operations. It is also released from areas where chemical wastes containing it are stored. It is frequently found in water. For example, tetrachloroethylene was found in 38% of 9,232 surface water sampling sites throughout the United States. There is no similar information on how often the chemical is found in air samples, but we know it is widespread. We do not know how often it is found in soil, but in one study, it was found in 5% of 359 sediment samples.

In general, tetrachloroethylene levels in air are higher in cities or industrial areas where it is in use more than in more rural or remote areas. You can smell it at levels of 1 ppm in air. However, the background level of tetrachloroethylene in air is usually less than 1 part in 1 billion parts of air (ppb). The air close to dry cleaning shops and chemical waste sites has levels of tetrachloroethylene higher than background levels. These levels are usually less than 1 ppm, the level at which you can smell it. Water, both above and below ground, may contain tetrachloroethylene. Levels in water are also usually less than 1 ppb. Levels in contaminated water near disposal sites are higher than levels in water far away from those sites. Water polluted with this chemical may have levels greater than 1 ppm. In soil, background levels are probably l00-1,000 times lower than 1 ppm.

You can also be exposed to tetrachloroethylene by using certain consumer products. Products that may contain it include water repellents, silicone lubricants, fabric finishers, spot removers, adhesives, and wood cleaners. Although uncommon, small amounts of tetrachloroethylene have been found in food, especially food prepared near a dry cleaning shop. When you bring clothes home from the dry cleaners, the clothes may release small amounts of tetrachloroethylene into the air. The full significance to human health of these exposures to small amounts of tetrachloroethylene is unknown, but to date, they appear to be relatively harmless. Tetrachloroethylene can also be found in the breast milk of mothers who have been exposed to the chemical.

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The people with the greatest chance of exposure to tetrachloroethylene are those who work with it. According to estimates from a survey conducted by the National Institute for Occupational Safety and Health (NIOSH), more than 650,000 U.S. workers may be exposed.

For the general population, the estimated amount that a person might breathe per day ranges from 0.08 to 0.2 milligrams. The estimated amount that most people might drink in water ranges from 0.0001 to 0.002 milligrams per day. These are very small amounts. For more information on the ways people might be exposed to tetrachloroethylene, see Chapter 5.

1.4 HOW CAN TETRACHLOROETHYLENE ENTER AND LEAVE MY BODY?

Tetrachloroethylene can enter your body when you breathe air containing it. How much enters your body in this way depends on how much of the chemical is in the air, how fast and deeply you are breathing, and how long you are exposed to it. Tetrachloroethylene may also enter your body when you drink water or eat food containing the chemical. How much enters your body in this way depends on how much of the chemical you drink or eat. These two exposure routes are the most likely ways people will take in tetrachloroethylene. These are also the most likely ways that people living near areas polluted with the chemical, such as hazardous waste sites, might be exposed to it. If tetrachloroethylene is trapped against your skin, a small amount of it can pass through into your body. Very little tetrachloroethylene in the air can pass through your skin into your body.

Most tetrachloroethylene leaves your body from your lungs when you breathe out. This is true whether you take in the chemical by breathing, drinking, eating, or touching it. A small amount of the tetrachloroethylene is changed by your body (especially your liver) into other chemicals that are removed from your body in urine. Most of the changed tetrachloroethylene leaves your body in a few days. Some of it that you take in is found in your blood and other tissues, especially body fat. Part of the tetrachloroethylene that is stored in fat may stay in your body for several days or weeks before it is eliminated. For more information on how tetrachloroethylene enters and leaves your body, see Chapter 2.

1.5 HOW CAN TETRACHLOROETHYLENE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Tetrachloroethylene has been used safely as a general anesthetic agent, so at high concentrations, it is known to produce loss of consciousness. When concentrations in air are high-particularly in closed, poorly ventilated areas-single exposures can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. Irritation may result from repeated or extended skin contact with the chemical. As you might expect, these symptoms occur almost entirely in work (or hobby) environments when individuals have been accidentally exposed to high concentrations or have intentionally abused tetrachloroethylene to get a "high." In industry, most workers are exposed to levels lower than those causing dizziness, sleepiness, and other nervous system effects. The health effects of breathing in air or drinking water with low levels of tetrachloroethylene are not definitely known. However, at levels found in the ambient air or drinking water, risk of adverse health effects is minimal. The effects of exposing babies to tetrachloroethylene through breast milk are unknown. Results from some studies suggest that women who work in dry cleaning industries where exposures to tetrachloroethylene can be quite high may have more menstrual problems and spontaneous abortions than women who are not exposed. However, it is not known for sure if tetrachloroethylene was responsible for these problems because other possible causes were not considered.

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that tetrachloroethylene can cause liver and kidney damage and liver and kidney cancers even though the relevance to people is unclear. Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that tetrachloroethylene may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that tetrachloroethylene is probably carcinogenic to humans. Exposure to very high levels of tetrachloroethylene can be toxic to the unborn pups of pregnant rats and mice. Changes in behavior were observed in the offspring of rats that breathed high levels of the chemical while they were pregnant Rats that were given oral doses of tetrachloroethylene when they were very young, when their brains were still developing, were hyperactive when they became adults. How tetrachloroethylene may affect the developing brain in human babies is not known.

For more information on the health effects of tetrachloroethylene, see Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO TETRACHLOROETHYLENE?

One way of testing for tetrachloroethylene exposure is to measure the amount of the chemical in the breath, much the same way breath alcohol measurements are used to determine the amount of alcohol in the blood. This test has been used to measure levels of the chemical in people living in areas where the air is contaminated with tetrachloroethylene or those exposed to the chemical through their work. Because it is stored in the body's fat and is slowly released into the bloodstream, it can be detected in the breath for weeks following a heavy exposure. Tetrachloroethylene can be detected in the blood. Also, breakdown products of the chemical can be detected in the blood and urine of people exposed to tetrachloroethylene. Trichloroacetic acid (TCA), a breakdown product of tetrachloroethylene can be detected for several days after exposure. These tests are relatively simple to perform. The breath, blood, or urine must be collected in special containers and then sent to a laboratory for testing. Because exposure to other chemicals can produce the same breakdown products in the urine and blood, the tests for breakdown products cannot determine if you have been exposed only to tetrachloroethylene. For more information on where and how tetrachloroethylene can be detected in your body after you have been exposed to it, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and NIOSH.

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for tetrachloroethylene include the following:

The EPA maximum contaminant level for the amount of tetrachloroethylene that-can be in drinking water is 0.005 milligrams tetrachloroethylene per liter of water (mg/L) (0.005 ppm).

EPA has established regulations and procedures for dealing with tetrachloroethylene, which it considers a hazardous waste. Many regulations govern its disposal. If amounts greater than

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100 pounds are released to the environment, the National Response Center of the federal government must be told immediately.

OSHA limits the amount of tetrachloroethylene that can be present in workroom air. This amount is limited to 100 ppm for an 8-hour workday over a 40-hour workweek. NIOSH recommends that tetrachloroethylene be handled as a chemical that might potentially cause cancer and states that levels of the chemical in workplace air should be as low as possible. For more information on regulations and guidelines to protect human health, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, Georgia 30333

*Information line and technical assistance

Phone: (404) 639-6000
Fax: (404) 639-6315 or 6324

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR 1,2-DICHLOROETHANE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 2001

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about 1,2-dichloroethane and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. 1,2-Dichloroethane has been found in at least 570 of the 1,585 current or former NPL sites. However, the total number of NPL sites evaluated for 1,2-dichloroethane is not known. As more sites are evaluated, the sites at which 1,2-dichloroethane is found may increase. This information is important because exposure to 1,2-dichloroethane may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to 1,2-dichloroethane, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS 1,2-DICHLOROETHANE?

1,2-Dichloroethane is a clear, manufactured liquid that is not found naturally in the environment. It evaporates quickly at room temperature and has a pleasant smell and a sweet taste. 1,2-Dichloroethane burns with a smoky flame. At this time, the most common use of 1,2-dichloroethane is to make vinyl chloride, which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes and other important construction materials, packaging materials, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. 1,2-Dichloroethane is also used as a solvent and is added to leaded gasoline to remove lead. In the past, it was also found in small amounts in products that industries used to clean cloth, remove grease from metal, and break down oils, fats, waxes, resins, and rubber. In the household, 1,2-dichloroethane was formerly a component of some cleaning solutions and pesticides; some adhesives, such as those used to glue wallpaper or carpeting; and some paint, varnish, and finish removers. Although large amounts of 1,2-dichloroethane are produced today, most is used to make other chemical products.

Small amounts of 1,2-dichloroethane that were released into water or soil evaporate into the air. 1,2-Dichloroethane that remains in soil from a spill or improper disposal can travel through the ground into water. The chemical may remain in water or soil for more than 40 days.

Chapter 4 contains more chemical and physical information about 1,2-dichloroethane. Chapter 5 has more information on its uses, and Chapter 6 tells about its presence in the environment.

1.2 WHAT HAPPENS TO 1,2-DICHLOROETHANE WHEN IT ENTERS THE ENVIRONMENT?

1,2-Dichloroethane can enter the environment when it is made, packaged, shipped, or used. Most 1,2-dichloroethane is released to the air, although some is released to rivers or lakes. 1,2-Dichloroethane could also enter soil, water, or air in large amounts in an accidental spill.

1,2-Dichloroethane evaporates into the air very fast from soil and water. In the air, it breaks down by reacting with other compounds formed by the sunlight. 1,2-Dichloroethane will stay in the air for more than 5 months before it is broken down. It may also be removed from air in rain or snow. Since it stays in the air for a while, the wind may carry it over large distances.

In water, 1,2-dichloroethane breaks down very slowly and most of it will evaporate to the air. Only very small amounts are taken up by plants and fish. We do not know exactly how long 1,2-dichloroethane remains in water, but we do know that it remains longer in lakes than in rivers.

In soil, 1,2-dichloroethane either evaporates into the air or travels down through soil and enters underground water. Small organisms living in soil and groundwater may transform it into other less harmful compounds, although this happens slowly. If a large amount of 1,2-dichloroethane enters soil from an accident, hazardous waste site, or landfill, it may travel a long way underground and contaminate drinking water wells.

More information on what happens to 1,2-dichloroethane in the environment can be found in Chapters 5 and 6.

1.3 HOW MIGHT I BE EXPOSED TO 1,2-DICHLOROETHANE?

Humans are exposed to 1,2-dichloroethane mainly by breathing air or drinking water that contains 1,2-dichloroethane. Human exposure usually happens where the chemical has been improperly disposed of, or spilled onto the ground. However, low levels of 1,2-dichloroethane have also been found in the air near industries where it is made or used in manufacturing. Humans can be exposed to low levels of 1,2-dichloroethane through the skin or air by contact with old products made with 1,2-dichloroethane, such as cleaning agents, pesticides, and adhesives used to glue wallpaper and carpets. Such exposure is probably not enough to cause harmful health effects.

1,2-Dichloroethane has been found in U.S. drinking water at levels ranging from 0.05 to 64 parts of 1,2-dichloroethane per billion (ppb) parts of water. An average amount of 175 ppb has been found in 12% of the surface water and groundwater samples taken at 2,783 hazardous wastes sites. 1,2-Dichloroethane has also been found in the air near urban areas at levels of 0.10–1.50 ppb and near hazardous waste sites at levels of 0.01–0.003 ppb. Small amounts of 1,2-dichloroethane have also been found in foods.

Humans may also be exposed to 1,2-dichloroethane through its use as a gasoline additive to reduce lead content, but these small levels are not expected to affect human health. This is probably not an important way that people are exposed to 1,2-dichloroethane in the United States, since leaded gasolines are rarely used today.

Additional information on levels in the environment and potential for human exposure are presented in Chapter 6.

1.4 HOW CAN 1,2-DICHLOROETHANE ENTER AND LEAVE MY BODY?

1,2-Dichloroethane can enter the body when people breathe air or drink water that contains 1,2-dichloroethane. Studies in animals also show that 1,2-dichloroethane can enter the body through the skin. Humans are most likely to be exposed at work and outside the workplace by drinking water that contains 1,2-dichloroethane, or by breathing 1,2-dichloroethane that has escaped from contaminated water or soil into the air.

Experiments in animals show that 1,2-dichloroethane that is breathed in or swallowed goes to many organs of the body, but usually leaves in the breath within 1 or 2 days. The breakdown products of 1,2-dichloroethane in the body leave quickly in the urine. Soil near hazardous waste sites probably does not have high amounts of 1,2-dichloroethane because it evaporates quickly into the air. This suggests that exposure near a hazardous waste site would most likely occur by breathing contaminated air rather than by touching contaminated soil.

Further information on how 1,2-dichloroethane can enter and leave the body is presented in Chapter 3.

1.5 HOW CAN 1,2-DICHLOROETHANE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

People who were accidentally exposed to large amounts of 1,2-dichloroethane in the air or who swallowed 1,2-dichloroethane by accident or on purpose often developed nervous system disorders and liver and kidney disease. Lung effects were also seen after a large amount of 1,2-dichloroethane was inhaled. People often died from heart failure. We do not know what levels of 1,2-dichloroethane caused these effects, but they are probably high. Studies in laboratory animals also found that breathing or swallowing large amounts of 1,2-dichloroethane produced nervous system disorders, kidney disease, or lung effects. Reduced ability to fight infection was also seen in laboratory animals who breathed or swallowed 1,2-dichloroethane, but we do not know if this also occurs in humans. Longer-term exposure to lower doses also caused kidney disease in animals.

So far, exposure to 1,2-dichloroethane has not been associated with cancer in humans. One study showed a relationship between increased cancer and exposure to pollutants in groundwater, including 1,2-dichloroethane, but the people were probably exposed to many other chemicals at the same time. Cancer was found in laboratory animals who were fed large doses of 1,2-dichloroethane. When 1,2-dichloroethane was put on the skin of laboratory animals, they developed lung tumors. We are not sure whether breathing 1,2-dichloroethane causes cancer in animals. Because of the cancer findings in animals, the possibility of cancer in humans cannot be ruled out. The Department of Health and Human Services (DHHS) has determined that 1,2-dichloroethane may reasonably be expected to cause cancer. The International Agency for Research on Cancer (IARC) has determined that 1,2-dichloroethane can possibly cause cancer in humans. EPA has determined that 1,2-dichloroethane is a probable human carcinogen.

Additional information regarding the health effects of 1,2-dichloroethane can be found in Chapter 3.

1.6 HOW CAN 1,2-DICHLOROETHANE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children can be exposed to 1,2-dichloroethane by breathing contaminated air, and possibly by drinking contaminated water. In the past, 1,2-dichloroethane had been used in certain household items, such as cleaning products and adhesives, but is no longer used in these products. There is a possibility that using of one of these older household products containing 1,2-dichloroethane to clean floors or glue carpets could result in exposure, since children often crawl on floors and play on carpets. Such exposures would probably last a few days or less, since 1,2-dichloroethane evaporates very quickly. Children are not likely to be exposed to 1,2-dichloroethane from parents' clothing or other items removed from the workplace. Because 1,2-dichloroethane has been detected in human milk, it is possible that young children could be exposed to 1,2-dichloroethane from breast-feeding mothers who had been exposed to sources of 1,2-dichloroethane.

There have been no studies of health effects in children exposed to 1,2-dichloroethane, and we have no reliable information on whether 1,2-dichloroethane causes birth defects in children. One study broadly suggests that heart problems could occur in the human fetus from mothers being exposed to 1,2-dichloroethane along with some other chemicals, but the information is not reliable enough for us to be sure whether 1,2-dichloroethane is responsible for the defects. Studies of pregnant laboratory animals indicate that it probably does not produce birth defects or affect reproduction. We do know, however, that when the pregnant animal is exposed to 1,2-dichloroethane, the fetus is probably also exposed.

It is likely that children exposed to 1,2-dichloroethane after birth would show the same health effects that are expected to occur in adults, especially liver and kidney disease. There is no information to determine whether children differ from adults in their sensitivity to the health effects of 1,2-dichloroethane.

More information regarding children's health and 1,2-dichloroethane can be found in Section 3.7.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO 1,2-DICHLOROETHANE?

If your doctor finds that you have been exposed to significant amounts of 1,2-dichloroethane, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

In the past, 1,2-dichloroethane was used in small amounts in household products such as cleaning agents, pesticides, and wallpaper and carpet glue. It is possible that you may have old containers of such products in your home. Risk of exposure from this source could be eliminated if these older products were immediately discarded. Otherwise, household chemicals should be stored out of reach of young children to prevent accidental poisonings. Always store household chemicals in their original labeled containers. Never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles. Keep your Poison Control Center's number next to the phone. Sometimes older children sniff household chemicals in an attempt to get high. Your children may be exposed to 1,2-dichloroethane by inhaling products containing it. Talk with your children about the dangers of sniffing chemicals. The exposure of your family to 1,2-dichloroethane can be reduced by throwing away any household products that contain it. You may wish to contact your county health department for appropriate disposal methods.

1,2-Dichloroethane has been found in drinking water in the United States. Most of the time, 1,2-dichloroethane has been found in small amounts that do not pose a major health risk. You may want to contact your water supplier or local health department to get information about the levels of 1,2-dichloroethane in the drinking water.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO 1,2-DICHLOROETHANE?

1,2-Dichloroethane has been found in the breath, blood, breast milk, and urine of exposed people. Because breath samples are easily collected, testing breathed-out or exhaled air is now a possible way to find out whether someone has recently been exposed to 1,2-dichloroethane. However, tests that measure small amounts in human breath, tissues, and fluids may not be available at your doctor's office because they require special equipment. Your physician can refer you to a facility where these tests are done. Although these tests can show that you have been exposed to 1,2-dichloroethane, it is not possible to tell if you will experience any harmful health effects. Because 1,2-dichloroethane leaves the body fairly quickly, these methods are best for finding exposures that occurred within the last several days. Exposure to 1,2-dichloroethane at hazardous waste sites will probably include exposure to other organic compounds at the same time. Therefore, levels of 1,2-dichloroethane measured in the body by these methods may not show exposure to 1,2-dichloroethane only. Medical tests available at a doctor's office include lung-, liver-, and kidney-function tests, but these tests look for damage that has already occurred from general chemical exposure and do not determine the cause of damage. Damage could also be the result of lifestyle (e.g., drinking alcohol, smoking) or general exposure to environmental agents. Other methods to measure the effects of exposure to 1,2-dichloroethane (such as abnormal enzyme levels) do not measure the effects of exposure to 1,2-dichloroethane only, but measure effects of other chemicals as well.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations <u>can</u> be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but <u>cannot</u> be enforced by law. Federal organizations that develop recommendations for toxic substances include the

Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for 1,2-dichloroethane include the following:

The federal government has developed regulatory standards and guidelines to protect people from the possible health effects of 1,2-dichloroethane in air. OSHA has set a limit of 50 parts of 1,2-dichloroethane per million parts of air (ppm, 1 ppm is 1,000 times more than 1 ppb) in the workplace for an 8-hour day, 40-hour week. NIOSH recommends that a person not be exposed daily in the workplace to more than 1 ppm 1,2-dichloroethane for a 10-hour day, 40-hour week. NIOSH calls 1,2-dichloroethane a possible occupational carcinogen. EPA also calls the compound a probable human cancer-causing agent, based on experiments in animals.

The federal government has also set regulatory standards and guidelines to protect people from the possible health effects of 1,2-dichloroethane in drinking water. EPA has set a limit in water of 0.005 milligrams of 1,2-dichloroethane per liter (5 ppb).

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737) or (404) 639-6357
Fax: (404) 639-6359

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological profiles, contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 605-6000

TOXICOLOGICAL PROFILE FOR TRICHLOROETHYLENE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 1997

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about trichloroethylene and the effects of exposure.

The Environmental Protection Agency (EPA) has identified 1,428 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are targeted for long-term federal clean-up. Trichloroethylene has been found in at least 861 NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As EPA looks at more sites, the sites with trichloroethylene may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it by breathing, eating, touching, or drinking.

If you are exposed to trichloroethylene, many factors will determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS TRICHLOROETHYLENE?

Trichloroethylene is also known as Triclene and Vitran and by other trade names in industry. It is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and a sweet, burning taste. Trichloroethylene is now mainly used as a solvent to remove grease from metal parts. It is also used as a solvent in other ways and is used to make other chemicals. Trichloroethylene can also be found in some household products, including typewriter correction fluid, paint removers, adhesives, and spot removers. Most people can begin to smell trichloroethylene in air when there are around 100 parts of trichloroethylene per million parts of air (ppm). Further information on the physical and chemical properties of trichloroethylene can be found in Chapter 3, and further information on its production and use can be found in Chapter 4.

1.2 WHAT HAPPENS TO TRICHLOROETHYLENE WHEN IT ENTERS THE ENVIRONMENT?

By far, the biggest source of trichloroethylene in the environment is evaporation from factories that use it to remove grease from metals. It can also enter the air and water when it is disposed of at chemical waste sites. It evaporates easily but can stay in the soil and in groundwater. Once it is in the air, about half will be broken down within a week. When trichloroethylene is broken down in the air, phosgene, a lung irritant, can be formed. Trichloroethylene can break down under high heat and alkaline conditions to form dichloroacetylene and phosgene. In the body, trichloroethylene may break down into dichloroacetic acid (DCA), trichloroacetic acid (TCA), chloral hydrate, and 2-chloroacetaldehyde. These products have been shown to be toxic to animals and are probably toxic to humans. Once trichloroethylene is in water, much will evaporate into the air; again, about half will break down within a week. It will take days to weeks to break down in surface water. In groundwater the breakdown is much slower because of the much slower evaporation rate. Very little trichloroethylene breaks down in the soil, and it can pass through the soil into underground water. It is found in some foods. The trichloroethylene found in foods is believed to come from contamination of the water used in food processing, or from food processing equipment cleaned with trichloroethylene. It does not build up in fish, but low levels have been found in them. It is not likely to build up in your body. For more information on trichloroethylene in the environment, see Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO TRICHLOROETHYLENE?

Trichloroethylene is found in the outdoor air at levels far less than 1 ppm. When measured several years ago, some of the water supplies in the United States were found to have tuichloroethylene. The most recent monitoring study found average levels in surface water ranging from 0.0001 to 0.001 ppm of water and an average level of 0.007 ppm in groundwater. About 400,000 workers are routinely exposed to trichloroethylene in the United States. The chemical can also get into the air or water in many ways, for example, at waste treatment facilities; by evaporation from paints, glues, and other products; or by release from factories where it is made. Another way you may be exposed is by breathing the air around factories that use the chemical. People living near hazardous waste sites may be exposed to it in the air or in their drinking water, or in the water used for bathing or cooking. Products that may contain trichloroethylene are some types of typewriter correction fluids, paints and paint removers, glues, spot removers, rug cleaning fluids, and metal cleaners. For more information on exposure to trichloroethylene, see Chapter 5.

1.4 HOW CAN TRICHLOROETHYLENE ENTER AND LEAVE MY BODY?

Trichloroethylene enters your body when you breathe air or drink water containing it. It can also enter your body if you get it on your skin. You could be exposed to contaminated water or air if you live near or work in a factory that uses trichloroethylene or if you live near a waste disposal site that contains trichloroethylene. If you breathe the chemical, about half the amount you breathe in will get into your bloodstream and organs. You will exhale the rest. If you drink trichloroethylene, most of it will be absorbed into your blood. If trichloroethylene comes in contact with your skin, some of it can enter your body, although not as easily as when you breathe or swallow it.

Once in your blood, your liver changes much of the trichloroethylene into other chemicals. The majority of these breakdown products leave your body in the urine within a day. You will also quickly breathe out much of the trichloroethylene that is in your bloodstream. Some of the trichloroethylene or its breakdown products can be stored in body fat for a brief period, and thus may build up in your body if exposure continues. For more information on trichloroethylene in your body, see Chapter 2.

1.5 HOW CAN TRICHLOROETHYLENE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Trichloroethylene was once used as an anesthetic for surgery. People who are exposed to large amounts of trichloroethylene can become dizzy or sleepy and may become unconscious at very high levels. Death may occur from inhalation of large amounts. Many people have jobs where they work with trichloroethylene and can breathe it or get it on their skin. Some people who get concentrated solutions of trichloroethylene on their skin develop rashes. People who breathe moderate levels of trichloroethylene may have headaches or dizziness. It is possible that some people who breathe high levels of trichloroethylene may develop damage to some of the nerves in the face. People have reported health effects when exposed to the level of trichloroethylene at which its odor is noticeable. Effects have also occurred at much higher levels. The effects reported at high levels include liver and kidney damage and changes in heart beat. The levels at which these effects occur in humans are not well characterized. Animals that were exposed to moderate levels of trichloroetbylene had enlarged livers, and high-level exposure caused liver and kidney damage.

It is uncertain whether people who breathe air or drink water containing trichloroethylene are at higher risk of cancer, or of having reproductive effects. More and more studies suggest that more birth defects may occur when mothers drink water containing trichloroethylene. People who used water for several years from two wells that had high levels of trichloroethylene may have had a higher incidence of childhood leukemia than other people, but these findings are not conclusive. In another study of trichloroethylene exposure from well water, increased numbers of children were reported to be born with heart defects, which is supported by data from some animal studies showing developmental effects of trichloroethylene on the heart. However, other chemicals were also in the water from this well and may have contributed to these effects. One study reported a higher number of children with a rare defect in the respiratory system and eye defects. Another study reported that the risk for neural tube defects and oral cleft palates were higher among mothers with trichloroethylene in their water during pregnancy. Children listed in the National Exposure Subregistry of persons exposed to trichloroethylene were reported to have higher rates of hearing and speech impairment. There are many questions regarding these reports. There were small numbers of children with defects and trichloroethylene levels at which the effects occurred were not defined well. Thus, it is not possible to make firm conclusions about the exact effects of trichloroethylene from these studies, and more studies need to be done.

We do not have any clear evidence that trichloroethylene alone in drinking water can cause leukemia or any other type of cancer in humans. As part of the National Exposure Subregistry, the Agency for Toxic Substances and Disease Registry (ATSDR) compiled data on 4,280 residents of three states (Michigan, Illinois, and Indiana) who had environmental exposure to trichloroethylene. It found no definitive evidence for an excess of cancers from trichloroethylene exposure. An increase of respiratory cancer was noted in older men, but this effect was thought to result from smoking rather than trichloroethylene exposure. A study in New Jersey found an association between leukemia in women and exposure to trichloroethylene in the drinking water. A study in Massachusetts found that exposure was associated with leukemia in children. In studies with people, there are many factors that are not fully understood. More studies need to be done to establish the relationship between exposure to trichloroethylene and cancer.

In studies using high doses of trichloroethylene in rats and mice, tumors in the lungs, liver, and testes were found, providing some evidence that high doses of trichloroethylene can cause cancer in experimental animals. Based on the limited data in humans regarding trichloroethylene exposure and cancer, and evidence that high doses of trichloroethylene can cause cancer in animals, the International Agency for Research on Cancer (IARC) has determined that trichloroethylene is probably carcinogenic to humans. Trichloroethylene has been nominated for listing in the National Toxicology Program (NTP) 9th Report on Carcinogens. Evaluation of this substance by the NTP review committee is ongoing. For more information on how trichloroethylene can affect your health see Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO TRICHLOROETHYLENE?

There are some tests that can show if you have been recently exposed to trichloroethylene since this chemical can be measured in your breath. Also, a doctor can have trichloroethylene or a number of breakdown products of trichloroethylene measured in your urine or blood. None of these tests, however, is routinely available at your doctor's office. If the measurements are done soon after the exposure, the breath levels can indicate whether you have been exposed to a large amount of trichloroethylene or only a small amount. Urine and blood tests can also show if you have been exposed to large amounts of this chemical. Because one of the breakdown products leaves your body very slowly, it can be measured in the urine for up to about 1 week after trichloroethylene exposure. However, exposure to other similar chemicals can produce the same breakdown products in your urine and blood. Therefore, these methods cannot determine for sure whether you have been exposed to trichloroethylene. For more information on medical tests, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals, then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an g-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for trichloroethylene include the following.

EPA has set a drinking water standard of 5 parts of trichloroethylene per one billion parts of water (ppb). One ppb is 1,000 times less than 1 ppm. This standard became effective on January 9, 1989, and applies to community water systems and those that serve the same 25 or more persons for at least 6 months. EPA requires industries to report spills of 1,000 pounds or more of trichloroethylene. It has been proposed that this level be reduced to 100 pounds.

Trichloroethylene levels in the workplace are regulated by the Occupational Safety and Health Administration (OSHA). The occupational exposure limit for an 8-hour workday, 40-hour workweek, is an average concentration of 100 ppm in air. The 15-minute average exposure in air that should not be exceeded at any time during a workday is 300 ppm. The OSHA standards are based on preventing central nervous system effects after trichloroethylene exposure. For more information, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, Georgia 30333

*Information line and technical assistance

Phone: (404) 639-6000
Fax: (404) 639-6315 or 6324

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

*To order toxicolopical profiles. contact:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone (800) 553-6847 or (703) 487-4650

TOXICOLOGICAL PROFILE FOR VINYL CHLORIDE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

September 1997

1. PUBLIC HEALTH STATEMENT

This public health statement tells you about vinyl chloride and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup. Vinyl chloride has been found in at least 496 of the 1,430 current or former NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As more sites are evaluated, the sites with vinyl chloride may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it by breathing, eating, touching, or drinking.

If you are exposed to vinyl chloride, many factors will determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS VINYL CHLORIDE?

Vinyl chloride is a colorless gas at normal temperatures. It is also known as chloroethene, chloroethylene, ethylene monochloride, or monochloroethylene. It is flammable (burns easily) as a gas and is not stable at high temperatures. Vinyl chloride exists in liquid form if it is kept under high pressure or at low temperatures (less than -13.4°C). Vinyl chloride has a mild, sweet odor. Most people begin to smell vinyl chloride in the air at 3,000 parts vinyl chloride per million parts (ppm) of air. However, the odor is of no value in preventing excess exposure. Most people begin to taste vinyl chloride in water at 3.4 ppm.

All vinyl chloride is manufactured or results from the breakdown of other manufactured substances, such as trichloroethylene, trichloroethane, and tetrachloroethylene. Production of vinyl chloride in the United States has grown at an average rate of 7% from the early 1980s to the early 1990s with an additional increase of approximately 22% between the years 1992 and 1993. Most of the vinyl chloride produced in the United States is used to make polyvinyl chloride (PVC). PVC is used to make a variety of plastic products including pipes, wire and cable coatings, and packaging materials. Other uses include furniture and automobile upholstery, wall coverings, housewares, and automotive parts. At one time, vinyl chloride was also used as a coolant, as a propellant in spray cans, and in some cosmetics. Since the mid-1970s it has not been used for these purposes. Please refer to Chapter 3 for more information on the chemical and physical properties of vinyl chloride. For more information on the production and use of vinyl chloride, see Chapter 4.

1.2 WHAT HAPPENS TO VINYL CHLORIDE WHEN IT ENTERS THE ENVIRONMENT?

Most of the vinyl chloride that enters the environment comes from the plastics industries, which release it into the air or into wastewater. EPA limits the amount that industries may release. Vinyl chloride is also a breakdown product of other synthetic chemicals in the environment. Vinyl chloride has entered the environment at hazardous waste sites as a result of its improper disposal or leakage from storage containers or from spills, but some may be from the breakdown of other chemicals. Vinyl chloride has been found in tobacco smoke, perhaps as a result of the manufacturing process.

Liquid vinyl chloride evaporates easily into the air. Vinyl chloride in water or soil evaporates rapidly if it is near the surface. Vinyl chloride in the air breaks down in a few days. When vinyl chloride breaks down in air, it can form other harmful chemicals.

A limited amount of vinyl chloride can dissolve in water. It can enter groundwater and can also be found in groundwater from the breakdown of other chemicals. It is unlikely that vinyl chloride will build up in plants or animals that you might eat. For more information on what happens to vinyl chloride in the environment, please see Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO VINYL CHLORIDE?

Since vinyl chloride commonly exists in a gaseous state, you are most likely to be exposed to it by breathing it. Vinyl chloride is not normally found in urban, suburban, or rural air in amounts that are detectable by the usual methods of analysis. However, vinyl chloride has been found in the air near plastics industries, hazardous waste sites, and landfills. The amount of vinyl chloride in the air near these places ranges from trace amounts to 0.041 ppm of air but may exceed 1 ppm. Levels as high as 44 ppm have been found in the air at some landfills. One can also be exposed to vinyl chloride in the air through tobacco smoke from cigarettes or cigars.

You may also be exposed to vinyl chloride by drinking water from contaminated wells, but how often this occurs is not known. Most drinking water supplies do not contain vinyl chloride. In a 1982 survey, vinyl chloride was found in less than 1% of the 945 groundwater supplies tested in the United States. The concentrations found in groundwater were up to 0.008 ppm, with a detection limit of 0.001 ppm. Other studies have reported groundwater vinyl chloride concentrations at or below 0.38 ppm. At one time, the flow of water through PVC pipes added very low amounts of vinyl chloride to water. For example, in one study of newly installed pipes, the drinking water had 0.001 ppm of vinyl chloride. No current information on the amount of vinyl chloride released from PVC pipes into water is available. In the past, vinyl chloride could get into food that was stored in materials that contained PVC. Now the U.S. government regulates the amount of vinyl chloride in food packaging materials. It has been estimated that when levels less than 1 ppm of vinyl chloride are used in PVC packaging, vinyl chloride in detectable amounts does not enter food by contact with these products.

Exposure to vinyl chloride can also occur in the workplace by breathing in any vapors in the air. Based on studies using animals, it is possible that if vinyl chloride comes into contact with your skin or eyes, extremely small amounts could enter your body. People who are exposed to vinyl chloride at their workplace include workers who make vinyl chloride and PVC.

Please refer to Chapter 5 for more information on ways that people are exposed to vinyl chloride.

1.4 HOW CAN VINYL CHLORIDE ENTER AND LEAVE MY BODY?

If vinyl chloride comes into contact with your skin, negligible amounts may pass through the skin and enter your body. Vinyl chloride is more likely to enter your body when you breathe air or drink water containing it. This could occur near certain factories or hazardous waste sites or in the workplace. Most of the vinyl chloride that you breathe or swallow enters your blood rapidly. The vinyl chloride in your blood travels through your body. When some portion of it reaches your liver, it is changed into several substances. Most of these new substances also travel in your blood. Once they reach your kidneys, they leave your body in your urine. Most of the vinyl chloride is gone from your body a day after you breathe or swallow it. The liver, however, makes some new substances that do not leave your body as rapidly. A few of these new substances are more harmful than vinyl chloride because they react with chemicals inside your body and interfere with the way your body normally uses or responds to these chemicals. Some of these substances react in the liver and, depending on how much vinyl chloride you breathe in, may cause damage there. It takes more time for your body to get rid of these changed chemicals, but eventually your body will remove them as well. If you breathe or swallow more vinyl chloride than your liver can chemically change, you will breathe out excess vinyl chloride. Chapter 2 contains more information on how vinyl chloride enters and leaves your body.

1.5 HOW CAN VINYL CHLORIDE AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

If you breathe high levels of vinyl chloride, yen will feel dizzy or sleepy. These effects occur within 5 minutes if you are exposed to about 10,000 ppm of vinyl chloride. You can easily smell vinyl chloride at this concentration. If you breathe still higher levels, you may pass out. You can rapidly recover from these effects if you breathe fresh air. Some people get a headache when they breathe fresh air immediately after breathing very high levels of vinyl chloride. People may die if they breathe extremely high levels of vinyl chloride. These levels are much higher than the levels that cause you to pass out. Studies in animals show that extremely high levels of vinyl chloride can damage the liver, lungs, and kidneys. These levels can also damage the heart and prevent blood clotting. The effects of ingesting vinyl chloride are unknown. If you spill liquid vinyl chloride on your skin, it will numb the skin and cause redness and blisters.

Some people who have breathed vinyl chloride for several years have changes in the structure of their livers People are more likely to develop these changes if they breathe high levels of vinyl chloride. Some people who have worked with vinyl chloride have nerve damage, and others have developed an immune reaction. The lowest levels that cause liver changes, nerve damage, and the immune reaction in humans are not known. Certain jobs related to PVC production expose workers to very high levels of vinyl chloride. Some of these workers have problems with the blood flow in their hands. Their fingers turn white and hurt when they go into the cold. It may take a long time to recover when they go into a warm place. In some of these people, changes have appeared on the skin of their hands and forearms. Also, bones at the tips of their fingers have broken down. Studies suggest that some people may be more sensitive to these effects than others.

Some men who work with vinyl chloride have complained of a lack of sex drive. Studies in animals showed that long-term exposure may damage the sperm and testes. Some women who work with vinyl chloride have reported irregular menstrual periods. Some have developed high blood pressure during pregnancy. Studies of women who live near vinyl chloride manufacturing plants did not show that vinyl chloride causes birth defects. Studies using pregnant animals showed that breathing high levels of vinyl chloride may harm unborn offspring. Animal studies also show that vinyl chloride may cause increased numbers of miscarriages early in pregnancy. It may also cause decreased weight and delayed skeletal development in fetuses. The same very high levels of vinyl chloride that caused these fetal effects also caused adverse effects in the pregnant animals.

Results from several studies have suggested that breathing air or drinking water containing low levels of vinyl chloride may increase the risk of getting cancer. However, the levels used in these studies were much higher than those found in the ambient air and/or most drinking water supplies. Studies of workers who have breathed vinyl chloride over many years showed increased risk of getting cancer of the liver. Brain cancer, lung cancer, and some cancers of the blood also may be connected with breathing vinyl chloride over long periods. Studies of long-term exposure in animals showed that increases in cancer of the liver and mammary gland may occur at very low levels of vinyl chloride in the air. Studies have shown that animals fed low levels of vinyl chloride each day during their lifetime had an increased risk of getting liver cancer.

The Department of Health and Human Services (DHHS) has determined that vinyl chloride is a known carcinogen. The International Agency for Research on Cancer (IARC) has determined that vinyl chloride is carcinogenic to humans, and EPA has determined that vinyl chloride is a human carcinogen.

More information on the health effects of vinyl chloride in humans and animals can be found in Chapter 2.

I.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO VINYL CHLORIDE?

The results of several tests can sometimes show if you have been exposed to vinyl chloride, depending on the amount of your exposure and how recently it bappened. However, scientists do not know if these measurements can tell how much vinyl chloride you have been exposed to. These tests are not normally available at your doctor's office. Vinyl chloride can be measured in your breath, but the test must be done shortly after exposure. This test is not very helpful for measuring very low levels of the chemical. The amount of the major breakdown product of vinyl chloride, thiodiglycolic acid, in the urine may give some information about exposure. However, this test must be done shortly after exposure and is not a reliable indicator of the level of exposure. Also, exposure to other chemicals can produce the same breakdown products in your urine. Vinyl chloride can bind to genetic material in your body. The amount of this binding can be measured by sampling your blood or tissue. This measurement will give information about whether you have been exposed to vinyl chloride, but it is not sensitive enough to determine the effects on the genetic material resulting from exposure. For more information, see Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of different exposure times (an g-hour workday or a 24hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for vinyl chloride include the following:

Vinyl chloride is regulated in drinking water, food, and air. Because it is a hazardous substance, regulations on its disposal, packaging, and other forms of handling also exist. EPA requires that the amount of vinyl chloride in drinking water not exceed 0.002 milligrams per liter (mg/L) of water (0.002 ppm). Under the EPA's Ambient Water Quality Criteria (AWQC) for the protection of human health, a concentration of zero has been recommended for vinyl chloride in ambient water.

In order to limit intake of vinyl chloride through foods to levels considered safe, the FDA regulates the vinyl chloride content of various plastics. These include plastics that carry liquids and plastics that come into contact with food. The limits for vinyl chloride content vary depending on the nature of the plastic and its use.

EPA has named vinyl chloride as a hazardous part of solid waste. If quantities greater than 1 pound (0.454 kilograms [kg]) are released to the environment, the National Response Center of the federal government must be told within 24 hours of the release.

OSHA regulates levels of vinyl chloride in the workplace. The maximum allowable amount of vinyl chloride in workroom air during an 8-hour workday in a 40-hour workweek is 1 ppm. The maximum amount allowed in any 15minute period is 5 ppm. NIOSH recommends that the exposure limit (for a time-weighted average [TWA]) for vinyl chloride in air be the lowest reliably detectable concentration Workers exposed to any measurable amount of it must wear special breathing equipment. EPA sets emission standards for vinyl chloride and PVC plants. The amount of vinyl chloride allowed to be emitted varies depending on the type of production and discharge system used.

Further regulations and guidelines that apply to vinyl chloride are presented in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, Georgia 30333

*Information line and technical assistance

Phone: (404) 639-6000
Fax: (404) 639-6315 or 6324

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR POLYCYCLIC AROMATIC HYDROCARBONS

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

August 1995

1. PUBLIC HEALTH STATEMENT

This statement was prepared to give you information about polycyclic aromatic hydrocarbons (PAHs) and to emphasize the human health effects that may result from exposure to them. The Environmental Protection Agency (EPA) has identified 1,408 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal clean-up activities. PAHs have been found in at least 600 of the sites on the NPL. However, the number of NPL sites evaluated for PAHs is not known. As EPA evaluates more sites, the number of sites at which PAHs are found may increase. This information is important because exposure to PAHs may cause harmful health effects and because these sites are potential or actual sources of human exposure to PAHs.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to substances such as PAHs, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, lifestyle, and state of health.

1.1 WHAT ARE POLYCYCLIC AROMATIC HYDROCARBONS?

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco and charbroiled meat. There are more than 100 different PAHs. PAHs generally occur as complex mixtures (for example, as part of combustion products such as soot), not as single compounds. PAHs usually occur naturally, but they can be manufactured as individual compounds for research purposes; however, not as the mixtures found in combustion products. As pure chemicals, PAHs generally exist as colorless, white, or pale yellow-green solids. They can have a faint, pleasant odor. A few PAHs are used in medicines and to make dyes, plastics, and pesticides. Others are contained in asphalt used in road construction. They can also be found in substances such as crude oil, coal, coal tar pitch, creosote, and roofing tar. They are found throughout the environment in the air, water, and soil. They can occur in the air, either attached to dust particles or as solids in soil or sediment.

Although the health effects of individual PAHs are not exactly alike, the following 17 PAHs are considered as a group in this profile:

- acenaphthene
- acenaphthylene
- anthracene
- benz[a]anthracene
- benzo[a]pyrene
- benzo[e]pyrene
- benzo[b]fluoranthene
- benzo[g,h,i]perylene
- benzo[j]fluoranthene
- benzo[k]fluoranthene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-c,d]pyrene
- phenanthrene
- pyrene

These 17 PAHs were chosen to be included in this profile because (1) more information is available on these than on the others; (2) they are suspected to be more harmful than some of the others, and they exhibit harmful effects that are representative of the PAHs; (3) there is a greater chance that you will be exposed to these PAHs than to the others; and (4) of all the PAHs analyzed, these were the PAHs identified at the highest concentrations at NPL hazardous waste sites.

More information can be found on the chemical and physical properties of PAHs in Chapter 3 and on their use and disposal in Chapter 4.

1.2 WHAT HAPPENS TO POLYCYCLIC AROMATIC HYDROCARBONS WHEN THEY ENTER THE ENVIRONMENT?

PAHs enter the environment mostly as releases to air from volcanoes, forest fires, residential wood burning, and exhaust from automobiles and trucks. They can also enter surface water through discharges from industrial plants and waste water treatment plants, and they can be released to soils at hazardous waste sites if they escape from storage containers. The movement of PAHs in the environment depends on properties such as how easily they dissolve in water, and how easily they evaporate into the air. PAHs in general do not easily dissolve in water. They are present in air as vapors or stuck to the surfaces of small solid particles. They can travel long distances before they return to earth in rainfall or particle settling. Some PAHs evaporate into the atmosphere from surface waters, but most stick to solid particles and settle to the bottoms of rivers or lakes. In soils, PAHs are most likely to stick tightly to particles. Some PAHs evaporate from surface soils to air. Certain PAHs in soils also contaminate underground water. The PAH content of plants and animals living on the land or in water can be many times higher than the content of PAHs in soil or water. PAHs can break down to longer-lasting products by reacting with sunlight and other chemicals in the air, generally over a period of days to weeks. Breakdown in soil and water generally takes weeks to months and is caused primarily by the actions of microorganisms. For more information on what happens to PAHs in the environment see Chapter 5.

1.3 HOW MIGHT I BE EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS?

PAHs are present throughout the environment, and you may be exposed to these substances at home, outside, or at the workplace. Typically, you will not be exposed to an individual PAH, but to a mixture of PAHs.

In the environment, you are most likely to be exposed to PAH vapors or PAHs that are attached to dust and other particles in the air. Sources include cigarette smoke, vehicle exhausts, asphalt roads, coal, coal tar, wildfires, agricultural burning, residential wood burning, municipal and industrial waste incineration, and hazardous waste sites. Background levels of some representative PAHs in the air are reported to be 0.02-1.2 nanograms per cubic meter (ng/m^3; a nanogram is one-millionth of a milligram) in rural areas and 0.15-19.3 ng/m^3 in urban areas. You may be exposed to PAHs in soil near areas where coal, wood, gasoline, or other products have been burned. You may be exposed to PAHs in the soil at or near hazardous waste sites, such as former manufactured-gas factory sites and wood-preserving facilities. PAHs have been found in some drinking water supplies in the United States. Background levels of PAHs in drinking water range from 4 to 24 nanograms per liter (ng/L; a liter is slightly more than a quart).

In the home, PAHs are present in tobacco smoke, smoke from wood fires, creosote-treated wood products, cereals, grains, flour, bread, vegetables, fruits, meat, processed or pickled foods, and contaminated cow's milk or human breast milk. Food grown in contaminated soil or air may also contain PAHs. Cooking meat or other food at high temperatures, which happens during grilling or charring, increases the amount of PAHs in the food. The level of PAHs in the typical U.S. diet is less than 2 parts of total PAHs per billion parts of food (ppb), or less than 2 micrograms per kilogram of food (μg/kg; a microgram is one-thousandth of a milligram).

The primary sources of exposure to PAHs for most of the U.S. population are inhalation of the compounds in tobacco smoke, wood smoke, and ambient air, and consumption of PAHs in foods. For some people, the primary exposure to PAHs occurs in the workplace. PAHs have been found in coal tar production plants, coking plants, bitumen and asphalt production plants, coal-gasification sites, smoke houses, aluminum production plants, coal tarring facilities, and municipal trash incinerators. Workers may be exposed to PAHs by inhaling engine exhaust and by using products that contain PAHs in a variety of industries such as mining, oil refining, metalworking, chemical production, transportation, and the electrical industry. PAHs have also been found in other facilities where petroleum, petroleum products, or coal are used or where wood, cellulose, corn, or oil are burned. People living near waste sites containing PAHs may be exposed through contact with contaminated air, water, and soil. For more information on human exposure to PAHs, see Chapter 5.

1.4 HOW CAN POLYCYCLIC AROMATIC HYDROCARBONS ENTER AND LEAVE MY BODY?

PAHs can enter your body through your lungs when you breathe air that contains them (usually stuck to particles or dust). Cigarette smoke, wood smoke, coal smoke, and smoke from many industrial sites may contain PAHs. People living near hazardous waste sites can also be exposed by breathing air containing PAHs. However, it is not known how rapidly or completely your lungs absorb PAHs. Drinking water and swallowing food, soil, or dust particles that contain PAHs are other routes for these chemicals to enter your body, but absorption is generally slow when PAHs are swallowed. Under normal conditions of environmental exposure, PAHs could enter your body if your skin comes into contact with soil that contains high levels of PAHs (this could occur near a hazardous waste site) or with used crankcase oil or other products (such as creosote) that contain PAHs. The rate at which PAHs enter your body by eating, drinking, or through the skin can be influenced by the presence of other compounds that you may be exposed to at the same time with PAHs. PAHs can enter all the tissues of your body that contain fat. They tend to be stored mostly in your kidneys, liver, and fat. Smaller amounts are stored in your spleen, adrenal glands, and ovaries. PAHs are changed by all tissues in the body into many different substances. Some of these substances are more harmful and some are less harmful than the original PAHs. Results from animal studies show that PAHs do not tend to be stored in your body for a long time. Most PAHs that enter the body leave within a few days, primarily in the feces and urine. More information on how PAHs enter and leave your body can be found in Chapters 2 and 6.

1.5 HOW CAN POLYCYCLIC AROMATIC HYDROCARBONS AFFECT MY HEALTH?

PAHs can be harmful to your health under some circumstances. Several of the PAHs, including benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno [1,2,3-c,d]pyrene, have caused tumors in laboratory animals when they breathed these substances in the air, when they ate them, or when they had long periods of skin contact with them. Studies of people show that individuals exposed by breathing or skin contact for long periods to mixtures that contain PAHs and other compounds can also develop cancer.

Mice fed high levels of benzo[a]pyrene during pregnancy had difficulty reproducing and so did their offspring. The offspring of pregnant mice fed benzo[a]pyrene also showed other harmful effects, such as birth defects and decreased body weight. Similar effects could occur in people, but we have no information to show that these effects do occur.

Studies in animals have also shown that PAHs can cause harmful effects on skin, body fluids, and the body's system for fighting disease after both short- and long-term exposure. These effects have not been reported in people.

The Department of Health and Human Services (DHHS) has determined that benz[a]anthracene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are known animal carcinogens. The International Agency for Research on Cancer (IARC) has determined the following: benz[a]anthracene and benzo[a]pyrene are probably carcinogenic to humans; benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-c,d]pyrene are possibly carcinogenic to humans; and anthracene, benzo[g,h,i]perylene, benzo[e]pyrene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene are not classifiable as to their carcinogenicity to humans. EPA has determined that benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene, and indeno[1,2,3-c,d]pyrene are probable human carcinogens and that acenaphthylene, anthracene, benzo[g,h,i]perylene, fluoranthene, fluorene, phenanthrene, and pyrene are not classifiable as to human carcinogenicity. Acenaphthene has not been classified for carcinogenic effects by the DHHS, IARC, or EPA. More information on the health effects associated with exposure to PAHs can be found in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS?

In your body, PAHs are changed into chemicals that can attach to substances within the body. The presence of PAHs attached to these substances can then be measured in body tissues or blood after exposure to PAHs. PAHs or their metabolites can also be measured in urine, blood, or body tissues. Although these tests can show that you have been exposed to PAHs, these tests cannot be used to predict whether any health effects will occur or to determine the extent or source of your exposure to the PAHs. It is not known how effective or informative the tests are after exposure is discontinued. These tests to identify PAHs or their products are not routinely available at a doctor's office because special equipment is required to detect these chemicals. More information on tests used to determine the presence of PAHs in your body is presented in Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has set regulations to protect people from the possible health effects of eating, drinking, or breathing PAHs. EPA has suggested that taking into your body each day the following amounts of individual PAHs is not likely to cause any harmful health effects: 0.3 milligrams (mg) of anthracene, 0.06 mg of acenaphthene, 0.04 mg of fluoranthene, 0.04 mg of fluorene, and 0.03 mg of pyrene per kilogram (kg) of your body weight (one kilogram is equal to 2.2 pounds). Actual exposure for most of the United States population occurs from active or passive inhalation of the compounds in tobacco smoke, wood smoke, and contaminated air, and from eating the compounds in foods. Skin contact with contaminated water, soot, tar, and soil may also occur. Estimates for total exposure in the United States population have been listed as 3 mg/day.

From what is currently known about benzo[a]pyrene, the federal government has developed regulatory standards and guidelines to protect people from the potential health effects of PAHs in drinking water. EPA has provided estimates of levels of total cancer-causing PAHs in lakes and streams associated with a risk of human cancer development. If the following amounts of individual PAHs are released to the environment within a 24-hour period, EPA must be notified: 1 pound of benzo[b]fluoranthene, benzo[a]pyrene, or dibenz[a,h]anthracene; 10 pounds of benz[a]anthracene; 100 pounds of acenaphthene, chrysene, fluoranthene, or indeno[1,2,3-c,d]pyrene; or 5,000 pounds of acenaphthylene, anthracene, benzo[k]fluoranthene, benzo[g,h,i]perylene, fluorene, phenanthrene, or pyrene.

PAHs are generally not produced commercially in the United States except as research chemicals. However, PAHs are found in coal, coal tar, and in the creosote oils, oil mists, and pitches formed from the distillation of coal tars. The National Institute for Occupational Safety and Health (NIOSH) concluded that occupational exposure to coal products can increase the risk of lung and skin cancer in workers. NIOSH established a recommended occupational exposure limit, time-weighted average (REL-TWA) for coal tar products of 0.1 milligram of PAHs per cubic meter of air (0.1 mg/m^3) for a 10-hour workday, within a 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an occupational exposure limit for coal tar products of 0.2 mg/m^3 for an 8-hour workday, within a 40-hour workweek. The Occupational Safety and Health Administration (OSHA) has established a legally enforceable limit of 0.2 mg/m^3 averaged over an 8-hour exposure period.

Mineral oil mists have been given an IARC classification of 1 (sufficient evidence of carcinogenicity). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist is 5 mg/m^3 averaged over an 8-hour exposure period. NIOSH has concurred with this limit, and has established a recommended occupational exposure limit (REL-TWA) for mineral oil mists of 5 mg/m^3 for a 10-hour work day, 40-hour work week, with a 10 mg/m^3 Short Term Exposure Limit (STEL).

More information on rules and standards for exposure to PAHs can be found in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333
(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR

NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

August 1995

1. PUBLIC HEALTH STATEMENT

This statement was prepared to give you information about naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene and to emphasize the human health effects that may result from exposure to them. The Environmental Protection Agency (EPA) has identified 1,408 hazardous waste sites as the most serious in the nation. These sites comprise the "National Priorities List" (NPL): those sites which are targeted for long-term federal cleanup activities. Naphthalene has been found in at 536 sites, 1-methylnaphthalene at 31 sites, and 2-methylnaphthalene at 328 of the sites on the NPL. However, the number of NPL sites evaluated for naphthalene, l-methylnaphthalene, and 2-methylnaphthalene is not known. As EPA evaluates more sites, the number of sites at which naphthalene, l-methylnaphthalene, and 2-methylnaphthalene is found may increase. This information is important because exposure to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene may cause harmful health effects and because these sites are potential or actual sources of human exposure to these chemicals.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to substances such as naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, gender, nutritional status, family traits, lifestyle, and state of health.

1.1 WHAT ARE NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE?

Naphthalene is a white solid that evaporates easily. It is also called mothballs, moth flakes, white tar, and tar camphor. When mixed with air, naphthalene vapors easily burn. Fossil fuels, such as petroleum and coal, naturally contain naphthalene. Burning tobacco or wood produces naphthalene. The major products made from naphthalene are moth repellents, in the form of mothballs or crystals, and toilet deodorant blocks It is also used for making dyes, resins, leather tanning agents, and the insecticide, carbaryl.

Naphthalene has a strong, but not unpleasant smell. Its taste is unknown, but must not be unpleasant since children have eaten mothballs and deodorant blocks You can smell naphthalene in the air at a concentration of 84 parts naphthalene per one billion parts (ppb) of air. You can smell it in water when 21 ppb are present.

1-Methylnaphthalene is a naphthalene-related compound which is also called alpha methylnaphthalene. It is a clear liquid. Its taste and odor have not been described, but you can smell it in water when only 7.5 ppb are present.

Another naphthalene-related compound, 2-methylnaphthalene, is also called beta methylnaphthalene. It is a solid like naphthalene. The taste and odor of 2-methylnaphthalene have not been described. Its presence can be detected at a concentration of 10 ppb in air and 10 ppb in water.

1-Methylnaphthalene and 2-methylnaphthalene are used to make other chemicals such as dyes, resins, and, for 2-methylnaphthalene, vitamin K. Along with naphthalene, they are present in cigarette smoke, wood smoke, tar, and asphalt, and at some hazardous waste sites.

See Chapters 3, 4, and 5 for more information on the properties and uses of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.

1.2 WHAT HAPPENS TO NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE WHEN THEY ENTER THE ENVIRONMENT?

Naphthalene enters the environment from industrial uses, from its use as a moth repellent, from the burning of wood or tobacco, and from accidental spills. Naphthalene at hazardous waste sites and landfills can dissolve in water. Naphthalene can become weakly attached to soil or pass through the soil into underground water.

Most of the naphthalene entering the environment is from the burning of woods and fossil fuels in the home. The second greatest release of naphthalene is through the use of moth repellents. Only about 10% of the naphthalene is from coal production and distillation, and less than 1% is attributable to naphthalene production losses. Cigarette smoking also releases small amounts of naphthalene.

Naphthalene evaporates easily. That is why you can smell mothballs. In the air, the moisture and sunlight make it break down, often within 1 day. The naphthalene can change to 1-naphthol or 2-naphthol. These chemicals have some of the toxic properties of naphthalene. Some naphthalene will dissolve in water in rivers, lakes, or wells. Naphthalene in water is destroyed by bacteria or evaporates into the air. Most of the naphthalene will be gone from rivers or lakes within 2 weeks. Naphthalene breaks down faster in water containing other pollutants, such as petroleum products.

Naphthalene binds weakly to soils and sediments. It easily passes through sandy soils to reach underground water. In soil, some microorganisms break down naphthalene. When near the surface of the soil, it will evaporate into air. Healthy soil will allow the growth of microorganisms which break down most of the naphthalene in 1 to 3 months. If the soil has few microorganisms, it will take about twice as long.

Microorganisms may change the chemical structure of naphthalene. Some common bacteria grow on naphthalene, breaking it down to carbon dioxide.

Naphthalene does not accumulate in the flesh of animals and fish that you might eat. If dairy cows are exposed to naphthalene, some naphthalene will be in their milk; if laying hens are exposed, some naphthalene will be in their eggs. Naphthalene and the methylnaphthalenes have been found in very small amounts in some samples of fish and shellfish from polluted waters.

Scientists know very little about what happens to 1-methylnaphthalene and 2-methylnaphthalene in the environment. These compounds are similar to naphthalene and should act like it in air, water, or soil.

See Chapters 4 and 5 for more information on what happens to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene in the environment.

1.3 HOW MIGHT I BE EXPOSED TO NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE?

You are most likely to be exposed to naphthalene, l-methylnaphthalene, or 2-methylnaphthalene from the air. Outdoor air contains low amounts of these chemicals, but burning wood or fossil fuels and industrial discharges can raise levels in the air surrounding them. This is true in cities with polluted air. Typical air concentrations for naphthalene are low, 0.2 ppb or less. Studies of outdoor air reported concentrations of 0.09 ppb 1-methylnaphthalene and 0.011 ppb 2-methylnaphthalene. In homes or businesses where cigarettes are smoked, wood is burned, or moth repellents are used, the levels of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene in the air are higher. Studies of indoor air typically report that average ambient air concentrations of these contaminants are less than 1 ppb.

You are not likely to be exposed to naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene by eating foods or drinking beverages from a store. These materials are unlikely to come in contact with naphthalene or methylnaphthalenes during production or processing Naphthalene and the methylnaphthalenes are also unlikely to be present in tap water.

If you live near a hazardous waste site and have a drinking water well, you might be exposed to naphthalene, 1-methylnaphthalene, or 2-methylnaphthalene. For this to happen, the chemicals must pass through the soil and dissolve in the underground water that supplies your well. Children might also contact these chemicals by playing in or eating the dirt near a waste site.

Work using or making moth repellents, coal tar products, dyes, or inks could expose you to naphthalene, l-methylnaphthalene, and 2-methylnaphthalene in the air. Working in the wood preserving, leather tanning, or asphalt industries could expose you to naphthalene.

Using moth repellents containing naphthalene in your home will expose you to naphthalene vapors. Use of naphthalene-treated clothing, blankets, or coverlets will expose you to naphthalene both by contacting your skin and by breathing its vapors. Cigarette smokers are exposed to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene in the smoke. The highest airborne naphthalene concentrations in nonoccupational settings occur in the homes of cigarette smokers.

See Chapter 5 for more information on how you might be exposed to naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.

1.4 HOW CAN NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE ENTER AND LEAVE MY BODY?

Naphthalene, l-methylnaphthalene, and 2-methylnaphthalene can enter your body if you breathe air that contains these chemicals, if you smoke, if you eat mothballs, if you drink water that contains these chemicals, of if they touch your skin. These chemicals are most likely to enter your body through the air you breath into your lungs. Naphthalene can also enter your body through your skin when you handle mothballs, particularly if you have used an oil-based skin lotion. You can also breathe in naphthalene vapors from clothes that have been stored in mothballs.

Once naphthalene, 1 -methylnaphthalene, and 2-methylnaphthalene enters your body, small amounts will dissolve in your blood. Your blood carries them to your liver and other organs. These organs change them so that they pass through your body, mainly into your urine. Some naphthalene, 2-methylnaphthalene, and their breakdown products can be present in your stool. Naphthalene has also been found in breast milk. Mother's milk and other secretions can also remove them from your body. It may take several weeks for all traces of naphthalene to leave your body.

Scientists do not know very much about 1-methylnaphthalene and 2-methylnaphthalene, but they think that they act somewhat like naphthalene in your body. Both of these compounds seem to be less toxic than naphthalene.

See Chapter 2 for more information on how naphthalene, l-methylnaphthalene, and 2-methylnaphthalene enter and leave your body.

1.5 HOW CAN NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE AFFECT MY HEALTH?

Exposure to a large amount of naphthalene may damage or destroy some of your red blood cells. This could cause you to have too few red blood cells until your body replaces the destroyed cells. This problem is called hemolytic anemia. People, particularly children, have developed this problem after eating naphthalene-containing mothballs or deodorant blocks. Anemia has also occurred in infants wearing diapers after storage in mothballs. If you are black or from a Mediterranean country, naphthalene may be more dangerous to you than to people of other races or nationalities. These populations have a higher incidence of problems with the enzyme, glucose-6-phosphate dehydrogenase (G6PD). This enzyme normally protects red blood cells from specific chemical damage created by oxygen in the air.

Some of the symptoms that occur with hemolytic anemia are fatigue, lack of appetite, restlessness, and a pale appearance to your skin Exposure to a lot of naphthalene may cause nausea, vomiting, diarrhea, blood in the urine, and a yellow color to the skin. If you have these symptoms, you should see a doctor quickly.

If you are a pregnant woman and anemic due to naphthalene exposure, there is a good chance that your unborn child will be anemic as well. Naphthalene can move from your blood to your baby's blood. Once your baby is born, naphthalene may also be carried from your body to your baby's body through your milk. It is not completely clear if naphthalene causes reproductive effects in animals; most evidence says it does not.

Laboratory rabbits, guinea pigs, mice, and rats sometimes develop cataracts (cloudiness) in their eyes after swallowing naphthalene. It is not clear if cataracts also develop in humans exposed to naphthalene, but the possibility exists.

When mice were repeatedly exposed to naphthalene vapors for 2 years, their noses and lungs became inflamed and irritated. Naphthalene, l-methylnaphthalene, and 2-methylnaphthalene seem to damage some cells in the lining of the lungs. When given naphthalene in their diets, mice had some effects in the spleen and thymus. Female mice that were exposed to naphthalene daily throughout their lives developed lung cancer that may have been related to their naphthalene exposure. Male rats or mice did not develop lung cancer.

The carcinogenicity (cancer causing ability) of naphthalene has not been determined. The Department of Health and Human Services (DHHS) has determined that naphthalene may cause cancer in female mice but not in male mice or rats of either sex. The International Agency for Research on Cancer (IARC) has determined that naphthalene is not classifiable as to its carcinogenicity to humans. The EPA has determined that naphthalene is not classifiable as to its carcinogenicity to humans.

See Chapter 2 for more information on the effects of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene on your health.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO NAPHTHALENE, 1-METHYLNAPHTHALENE, AND 2-METHYLNAPHTHALENE?

Several tests can find out if you have been exposed to naphthalene. These tests include measuring naphthalene and naphthalene breakdown products in urine, stool, blood, or maternal milk. If you have eaten something made from naphthalene, like mothballs, your stool can be checked for unabsorbed naphthalene. A small sample of your body fat can be removed and analyzed for naphthalene. Tests for naphthalene and naphthalene breakdown products require special equipment and are not routinely available in a doctor's office. Body fluids, urine, stool samples, or tissue samples can be sent to a special laboratory for the tests. These tests cannot determine exactly how much naphthalene you were exposed to or predict whether harmful effects will occur. The tests can show if you were exposed to a large or small amount of naphthalene. Urine tests, like stool tests, stop working 8-24 hours after naphthalene has passed through your body.

2-Methylnaphthalene and its breakdown products can be detected in the urine. Scientists know little about 1-methylnaphthalene or how to easily test for exposure to it.

See Chapters 2 and 6 for more information on tests for exposure to naphthalene, 1 -methylnaphthalene, and 2-methylnaphthalene.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has developed regulations and advisories to protect individuals from the possible health effects of naphthalene in the environment. The Occupational Safety and Health Administration (OSHA) set a limit of 10 parts per million (ppm) for the level of naphthalene in workplace air over an g-hour workday. The National Institute for

Occupational Safety and Health (NIOSH) considers more than 500 ppm of naphthalene in air to be immediately dangerous to life or health.

The EPA recommends that children not drink water with over 0.5 ppm naphthalene for more than 10 days or over 0.4 ppm for any longer than 7 years. Adults should not drink water with more than 1 ppm for more than 7 years. For water consumed over a lifetime, EPA suggests it contain no more than 0.02 ppm naphthalene.

Industrial releases of naphthalene into the environment of more than 100 pounds must be reported to EPA.

There are no regulations or advisories for 1-methylnaphthalene or 2-methylnaphthalene now.

See Chapter 7 for more information on government regulations for naphthalene

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE
Atlanta, Georgia 30333
(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR NITROBENZENE

Agency for Toxic Substances and Disease Registry
U.S. Public Health Service

December 1990

1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about nitrobenzene and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,177 sites on its National Priorities List (NPL). Nitrobenzene has been found at 7 of these sites. However, we do not know how many of the 1,177 NPL sites have been evaluated for nitrobenzene. As EPA evaluates more sites, the number of sites at which nitrobenzene is found may change. The information is important for you because nitrobenzene may cause harmful health effects and because these sites are potential or actual sources of human exposure to nitrobenzene.

When a chemical is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous substance such as nitrobenzene, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

1.1 WHAT IS NITROBENZENE?

Nitrobenzene is an oily yellow liquid with an almond-like odor. It may be pale yellow-brown in appearance. It dissolves only slightly in water, but very easily in some other chemicals.

Nitrobenzene is produced in large quantities for industrial use. Approximately 98% of the nitrobenzene produced in the United States is used to manufacture a chemical known as aniline. Nitrobenzene is also used to produce lubricating oils such as those used in motors and machinery. A very small amount of nitrobenzene is used in the manufacture of dyes, drugs, pesticides, and synthetic rubber.

Small amounts of nitrobenzene are released to the air and to bodies of water by the industries that use this chemical. However, it is broken down to other chemicals within a few days after it is released. Air and water in most areas contain no nitrobenzene or such low amounts that they cannot be measured.

More information on the chemical and physical properties of nitrobenzene can be found in Chapter 3. Its production, import, uses, and disposal are presented in Chapter 4, and its occurrence and fate in the environment are described in Chapter 5.

1.2 HOW MIGHT I BE EXPOSED TO NITROBENZENE?

Because nitrobenzene is not usually found at hazardous waste sites, it is unlikely that you will be exposed to nitrobenzene if you live near one of these sites. However, you may be exposed if you live near one of the seven waste sites where it has been found or near a manufacturing or processing plant, such as those involved in petroleum refining and chemical manufacturing. Persons in these areas may be exposed to nitrobenzene in the air they breathe. However, even in these cases, the levels of nitrobenzene have been found to be extremely low, usually less than 1 ppb (one part nitrobenzene per billion parts of air). Levels of nitrobenzene in the air of residential areas are even lower. Nitrobenzene is almost never found in drinking water. There is no information available on the levels of nitrobenzene in food.

The most common way that humans are exposed to this compound is by occupational exposure. If you work in a plant or factory that produces nitrobenzene or uses nitrobenzene to make other products such as dyes, drugs, pesticides or synthetic rubber, you may be exposed to nitrobenzene in the air that you breathe or through your skin.

For more information on human exposure to nitrobenzene, see Chapter 5.

1.3 HOW CAN NITROBENZENE ENTER AND LEAVE MY BODY?

Nitrobenzene can enter your body easily and quickly through your lungs, through your skin, or if you eat or drink contaminated food or water. Nitrobenzene is easily absorbed through the skin and this is a frequent pathway of human exposure. Drinking alcoholic beverages may result in nitrobenzene entering your body at a faster rate, no matter how you are exposed.

Nitrobenzene and its breakdown products leave the body within a few days. These are eliminated mostly in the urine and to a smaller extent in the feces.

More information on how nitrobenzene enters and leaves the body can be found in Chapter 2.

1.4 HOW CAN NITROBENZENE AFFECT MY HEALTH?

Nitrobenzene can cause a wide variety of harmful health effects to exposed persons. Direct contact of small amounts of nitrobenzene with the skin or eyes may cause mild irritation. Repeated exposures to a high concentration of nitrobenzene can result in a blood condition called methemoglobinemia. This condition affects the ability of the blood to carry oxygen. Following such an exposure, the skin may turn a bluish color. This may be accompanied by nausea, vomiting and shortness of breath. Effects such as headache, irritability, dizziness, weakness, and drowsiness may also occur. If the exposure level is extremely high, nitrobenzene can cause coma and possibly death unless prompt medical treatment is received. Consuming alcoholic beverages during nitrobenzene exposure may increase the harmful effects of nitrobenzene.

In studies with laboratory animals, a single dose of nitrobenzene fed to male rats resulted in damage to the testicles and decreased levels of sperm. This suggests that decreased fertility may be a concern in humans. There is very little information available about the effects of long-term exposure of humans or animals to nitrobenzene, and it is not known whether exposure to nitrobenzene can cause cancer.

Further information on the health effects of nitrobenzene in humans and animals can be found in Chapter 2. More information on nitrobenzene breakdown products can be found in Chapter 2. There are populations that are unusually susceptible to nitrobenzene, and this is further discussed in Chapter 2.

1.5 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Tables 1-1 through 1-4 show the relationship between exposure to nitrobenzene at certain levels and known health effects. The exposure of laboratory animals to nitrobenzene through skin contact has resulted in harmful effects similar to those seen in laboratory animals by other routes of exposure. In general, the longer the period of contact with the skin, the more severe the effects.

Nitrobenzene can be smelled in water when it is present at 0.11 mg/L (milligrams of nitrobenzene per liter of water) or in air at 0.018 ppm (0.018 parts of nitrobenzene per million parts of air). It has an odor characteristic of bitter almonds or shoe polish.

TABLE 1-1. **Human Health Effects from Breathing Nitrobenzene**

Levels in Air	Length of Exposure	Description of Effects
Short-term Exposure (less than or equal to 14 days)		
		The health effects resulting from short-term exposure of humans to air containing specific levels of nitrobenzene are not known.
Long-term Exposure (greater than 14 days)		
		The health effects resulting from long-term exposure of humans to air containing specific levels of nitrobenzene are not known.

TABLE 1-2. Animal Health Effects from Breathing Nitrobenzene

Levels in Air (ppm)	Length of Exposure	Description of Effects*
Short-term Exposure (less than or equal to 14 days)		
10	10 to 14 days	Increased liver, kidney and spleen weights and methemoglobinemia in rats.
125	14 days	Brain lesions in mice; death in rats.
Long-term Exposure (greater than 14 days)		
5	90 days	Damage to the kidneys and increased methemoglobinemia in rats.
50	90 days	Damage to the spleen, liver, and testes of rats.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

TABLE 1-3. Human Health Effects from Eating or Drinking Nitrobenzene

Short-term Exposure (less than or equal to 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of humans to food containing specific levels of nitrobenzene are not known.
Levels in Water		
		The health effects resulting from short-term exposure of humans to water containing specific levels of nitrobenzene are not known.

Long-term Exposure (greater than 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from long-term exposure of humans to food containing specific levels of nitrobenzene are not known.
Levels in Water		
		The health effects resulting from long-term exposure of humans to water containing specific levels of nitrobenzene are not known.

TABLE 1-4. Animal Health Effects from Eating or Drinking Nitrobenzene

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)	Length of Exposure	Description of Effects*
4,000	1 day	Methemoglobinemia in rats.
6,000	1 day	Testicle damage in rats.
11,000	1 day	Brain hemorrhage in rats.
Levels in Water		
		The health effects resulting from short-term exposure of animals to water containing specific levels of nitrobenzene are not known.
Long-term Exposure (greater than 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from long-term exposure of animals to food containing specific levels of nitrobenzene are not known.
Levels in Water		
		The health effects resulting from long-term exposure of animals to water containing specific levels of nitrobenzene are not known.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

More information on the health effects associated with exposure to nitrobenzene is presented in Chapter 2.

1.6 WHERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO NITROBENZENE?

Nitrobenzene reacts with red blood cells in the body to produce methemoglobin. If you have recently been exposed to nitrobenzene, the levels of methemoglobin in your blood will be elevated. This level can be measured. However, many toxic chemicals produce methemoglobin, and this method does not give specific information about nitrobenzene exposure.

In cases of long-term exposure to nitrobenzene, the presence of its breakdown products, p-nitrophenol and p-aminophenol, in the urine is an indication of nitrobenzene exposure. These tests require special equipment and cannot be routinely done in a doctor's office. The results of these tests cannot be used to determine the level of nitrobenzene exposure or if harmful health effects can be expected to occur.

Information regarding tests for the detection of nitrobenzene in the body is presented in Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has developed regulations and guidelines in order to protect individuals from the possible health effects of nitrobenzene in drinking water. The Environmental Protection Agency (EPA) has concluded that the amount of nitrobenzene in drinking water should not exceed 19.8 mg/L and that any release in excess of 1,000 pounds should be reported.

The Occupational Safety and Health Administration (OSHA) has set a legal limit (Permissible Exposure Limit, or PEL) of 1 ppm in workroom air to protect workers during an 8-hour shift in a 40-hour workweek.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns not covered here, please contact your State Health or Environmental Department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333

This agency can also give you information on the location of the nearest occupational and environmental health clinics. Such clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

TOXICOLOGICAL PROFILE FOR N-NITROSODI-n-PROPYLAMINE

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Public Health Service

In collaboration with
U.S. Environmental Protection Agency (EPA)

December 1989

1. PUBLIC HEALTH STATEMENT

1.1 WHAT IS N-NITROSODI-n-PROPYLAMINE?

N-Nitrosodi-n-propylamine is a yellow liquid at room temperature that does not disssolve in water and evaporates slowly. It is a man-made chemical made in small amounts for use in research. There is no evidence that N-nitrosodi-n-propylamine exists naturally in soil, air, food, or water. Small amounts of N-nitrosodi-n-propylamine are produced as a side reaction during some manufacturing processes, as a contaminant in some commonly available weed killers (dinitroaniline-based), and during the manufacture of some rubber products. When exposed to sunlight, N-nitrosodi-n-propylamine usually does not last for more than a day. Without sunlight (e.g, in water deeper than sunlight reaches or in subsurface soil) N-nitrosodi-n-propylamine breaks down slowly. It takes between 14 and 80 days for one-half of any certain amount of N-nitrosodi-n-propylamine to break down when it is released to the subsurface soil. More information can be found in Chapters 3, 4, and 5.

1.2 HOW MIGHT I BE EXPOSED TO N-NITROSODI-n-PROPYLAMINE?

Persons may be exposed to N-nitrosodi-n-propylamine by eating foods treated with nitrite preservatives (e.g., cheeses, cured meats) and drinking certain alcoholic beverages. N-Nitrosodi-n-propylamine forms in the stomach during digestion of nitrite-treated foods and foods that contain certain amines, particularly di-n-propylamine. Amines occur in some medicines and in a variety of foods. Levels of N-nitrosodi-n-propylamine found in food and alcoholic beverages range between 0.03 parts per billion (ppb) in fried, salt-preserved fish to 30 ppb in cheese. The general population may be exposed to N-nitrosodi-n-propylamine in cigarette smoke. Workers making molded rubber products have been exposed to levels of N-nitrosodi-n-propylamine in workroom air that were measured in parts of compound per trillion parts (ppt) of air. Workers applying contaminated weed killers may also be exposed to extremely low (ppt) levels of N-nitrosodi-n-propylamine. At this time, N-nitrosodi-n-propylamine has been found in at least 1 of 1177 hazardous waste sites on the National Priorities List (NPL) in the United States. Workers and the general population at these sites could possibly be exposed to this compound by skin contact, breathing, and eating contaminated items. For more information, refer to Chapter 5.

1.3 HOW CAN N-NITROSODI-n-PROPYINE ENTER AND LEAVE MY BODY?

N-Nitrosodi-n-propylamine can enter the body when a person breathes air that contains N-nitrosodi-n-propylamine, or eats food or drinks water contaminated with N-nitrosodi-n-propylamine. N-nitrosodi-n-propylamine is not likely to get into your body unless you eat certain foods, drink alcoholic beverages, or are exposed to it at a waste disposal site by breathing N-nitrosodi-n-propylamine vapors. It is likely that N-nitrosodi-n-propylamine can enter the body by direct skin contact with wastes, pesticides, or soil that contains it. Experiments with animals suggest that if N-nitrosodi-n-propylamine enters the body, it will be broken down into other compounds and will leave the body in the urine. More information on how N-nitrosodi-n-propylamine can enter and leave your body is given in Chapter 2.

1.4 HOW CAN N-NITROSODI-n-PROPYLAMINE AFFECT MY HEALTH?

The effects of short- or long-term exposures to N-nitrosodi-n-propylamine on human health have not been studied. Little is known about the health effects of short exposures to N-nitrosodi-n-propylamine in experimental animals except that eating or drinking certain amounts of this chemical can cause liver disease and death. Long-term exposure of experimental animals to N-nitrosodi-n-propylamine in food or drinking water causes cancer of the liver, esophagus, and nasal cavities. Although human studies are not available, the animal evidence indicates that it is reasonable to expect that exposure to N-nitrosodi-n-propylamine by eating or drinking could cause liver disease and cancer in humans. It is not known .whether other effects, such as birth defects, occur in animals or could occur in humans exposed to N-nitrosodi-n-propylamine by eating or drinking. It is also not known whether exposure to N-nitrosodi-n-propylamine by breathing contaminated air or contact with the skin can affect the health of animals or humans. Liver disease and cancer due to exposure to N-nitrosodi-n-propylamine by breathing or skin contact are, however, a possibility and a health concern. More information on the health effects of N-nitrosodi-n-propylamine is given in Chapter 2.

1.5 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO N-NITROSODI-n-PROPYLAMINE?

The presence of N-nitrosodi-n-propylamine in blood and urine can be measured by chemical analysis, but this analysis is not usually available at your doctor's office and has not been used to test for human exposure or to predict possible health effects. These considerations are discussed in more detail in Chapter 2.

1.6 WHAT LEVELS OF EXPOSURE HAVE RESULTED IN HARMFUL HEALTH EFFECTS?

Tables 1-1 through 1-4 show the relationship between exposure to N-nitrosodi-n-propylamine and known health effects. As indicated in Tables 1-1 and 1-2, nothing is known about the health effects on humans or animals of breathing N-nitrosodi-n-propylamine. Also, nothing is known-about the health effects in humans of eating food or drinking water containing N-nitrosodi-n-propylamine (Table 1-3). A Minimal Risk Level (MRL) is also included in Table 1-3. This MRL was derived from animal data for short-term exposure as described in Chapter 2 and in Table 2-1. The MRL provides a basis for comparison with levels that people might encounter in drinking water. If a person is exposed to N-nitrosodi-n-propylamine at an amount

TABLE 1-1. Human Health Effects from Breathing N-Nitrosodi-n-propylamine*

Levels in Air	Length of Exposure	Description of Effects
Short-term Exposure (less than or equal to 14 days)		
		The health effects resulting from short-term exposure of humans to air containing N-nitrosodi-n-propylamine are not known.
Long-term Exposure (greater than 14 days)		
		The health effects resulting from long-term exposure of humans to air containing N-nitrosodi-n-propylamine are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-2. Animal Health Effects from Breathing N-Nitrosodi-n-propylamine

Short-term Exposure (less than or equal to 14 days)		
Levels in Air	**Length of Exposure**	**Description of Effects**
		The health effects resulting from short-term exposure of animals to air containing N-nitrosodi-n-propylamine are not known.
Long-term Exposure (greater than 14 days)		
Levels in Air	**Length of Exposure**	**Description of Effects**
		The health effects resulting from long-term exposure of animals to air containing N-nitrosodi-n-propylamine are not known.

TABLE 1-3. *Human Health Effects from Eating or Drinking* N-Nitrosodi-n-propylamine*

Short-term Exposure (less than or equal to 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from short-term exposure of humans to food containing N-nitroso-di-n-propylamine are not known.
Levels in Water (ppm)		
3.3		Minimal risk level (based on animal data; see Section 1.6 for discussion).
Long-term Exposure (greater than 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from long-term exposure of humans to food containing N-nitroso-di-n-propylamine are not known.
Levels in Water		The health effects resulting from long-term exposure of humans to food containing N-nitrosodi-n-propylamine are not known.

*See Section 1.2 for a discussion of exposures encountered in daily life.

TABLE 1-4. Animal Health Effects from Eating or Drinking N-Nitrosodi-n-propylamine

Short-term Exposure (less than or equal to 14 days)		
Levels in Food (ppm)		
308	4 days	Liver injury in mice.
Levels in Water (ppm)	Length of Exposure	Description of Effects*
3429	once	Liver injury and death in rats.
Long-term Exposure (greater than 14 days)		
Levels in Food	Length of Exposure	Description of Effects
		The health effects resulting from long-term animal exposure to food containing specific levels of N-nitrosodi-n-propylamine are not known.
Levels in Water		The health effects resulting from long-term animal exposure to water containing specific levels of N-nitrosodi-n-propylamine are not known.

*These effects are listed at the lowest level at which they were first observed. They may also be seen at higher levels.

below the MRL, it is not expected that harmful (noncancer) health effects will occur. Because this level is based on information that is currently available, some uncertainty is always associated with it. Also, because the method for deriving MRLs does not use any information about cancer, an MRL does not imply anything about the presence, absence, or level of risk of cancer. The levels of N-nitrosodi-n-propylamine in food and drinking water linked with known health effects in animals are given in Table 1-4. It is not known whether skin contact with N-nitrosodi-n-propylamine can affect the health of humans or animals. More information on levels of exposure linked with adverse health effects can be found in Chapter 2.

1.7 RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The EPA controls the release of N-nitrosodi-n-propylamine. It is proposed that releases or spills of 10 pounds or more of N-nitrosodi-n-propylamine must be reported to the National Response Center.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have more questions or concerns, please contact your State Health or Environmental Department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333